

# Engine

**GROUP  
21**

<b>PART 21-01</b>	<b>PAGE</b>	<b>PART 21-05</b>	<b>PAGE</b>
General Engine Service .....	<b>21-01-01</b>	351-C V-8 Engine .....	<b>21-05-01</b>
<b>PART 21-02</b>		<b>PART 21-06</b>	
170, 200 and 250 - Six Engine .....	<b>21-02-01</b>	390 and 428 V-8 Engine .....	<b>21-06-01</b>
<b>PART 21-03</b>		<b>PART 21-07</b>	
240 - Six Engine .....	<b>21-03-01</b>	429 and 460 V-8 Engines .....	<b>21-07-01</b>
<b>PART 21-04</b>		<b>PART 21-08</b>	
302, 351 and 302 BOSS V-8 Engines .....	<b>21-04-01</b>	429 BOSS V-8 Engine .....	<b>21-08-01</b>

## **PART 21-01 General Engine Service**

COMPONENT INDEX	Page	COMPONENT INDEX	Page
CAMSHAFT		CYLINDER HEADS	
Cleaning .....	01-20	Cleaning .....	01-18
Core Plug Replacement .....	01-16	Inspection .....	01-18
End Play Check .....	01-09	Repairs .....	01-10
Inspection .....	01-12	EXHAUST CONTROL VALVE-240 SIX	
Lobe Lift Check .....	01-04	Installation .....	01-14
COMPRESSION TEST	01-04	Removal .....	01-13
CONNECTING RODS		EXHAUST MANIFOLDS	
Cleaning .....	01-21	Cleaning .....	01-17
Inspection .....	01-21	Inspection .....	01-18
CRANKSHAFT		FLYWHEEL	
Cleaning .....	01-20	Face Runout Check-Manual Shift Transmissions .....	01-08
End Play Check .....	01-08	Flywheel Ring Gear-Manual Shift Transmissions .....	01-21
Inspection .....	01-20	Inspection-Automatic Transmission .....	01-21
Repairs .....	01-12	Inspection-Manual-Shift Transmissions .....	01-21
CRANKCASE VENTILATION SYSTEM		Runout Check-Automatic Transmissions .....	01-09
Cleaning .....	01-23	FUEL PUMP ECCENTRIC	
Component Tests .....	01-06	Cleaning .....	01-20
Inspection .....	01-06	Inspection .....	01-20
CRANKSHAFT VIBRATION DAMPER AND SLEEVE		INTAKE MANIFOLD	
Cleaning .....	01-20	Cleaning .....	01-17
Inspection .....	01-20	Inspection .....	01-17
CYLINDER BLOCK		Manifold Vacuum Test .....	01-04
Cleaning .....	01-22	MAIN AND CONNECTING ROD BEARINGS ..	
Inspection .....	01-22	Cleaning .....	01-22
Repairs .....	01-14	Fitting with Plastigage .....	01-12
		Inspection .....	01-22
		OIL PAN	
		Cleaning .....	01-23
		Inspection .....	01-23

COMPONENT INDEX	Page	COMPONENT INDEX	Page
OIL PUMP		VALVES	
Cleaning .....	01-23	Refacing .....	01-12
Inspection .....	01-23	Select Fitting .....	01-12
PISTONS, PINS AND RINGS		VALVE LIFTERS-HYDRAULIC	
Repair .....	01-12	Cleaning .....	01-19
Inspection .....	01-21	Inspection .....	01-20
THERMATOR EXHAUST EMISSION CONTROL SYSTEM		Tests-Leakdown Rate .....	01-05
Component Tests .....	01-07	VALVE PUSH RODS	
Inspection .....	01-23	Cleaning .....	01-18
TIMING CHAIN AND SPROCKETS		Inspection .....	01-10
Chain Deflection Check .....	01-09	VALVE TAPPETS-SOLID	
Cleaning .....	01-20	Cleaning .....	01-20
Inspection .....	01-20	Inspection .....	01-20
TIMING GEARS		VALVE ROCKER ARM AND/OR SHAFT ASSEMBLY	
Cleaning .....	01-20	Cleaning .....	01-18
Backlash Check .....	01-09	Inspection .....	01-18
Inspection .....	01-20	Repairs .....	01-10
Runout-Check .....	01-09		

The 1970 vehicle engines incorporate a closed-type crankcase ventilation system and either a Thermator or Imco-type exhaust emission system to control engine emissions within Government specifications.

To maintain the required exhaust emission levels, the carburetor must be kept in good operating condition and adjusted to specifications, and the engine should be in good operating condition.

Additional engine performance checks are required to keep the exhaust emissions at the specified minimum pollutant level. Refer to the applicable owners manual for these performance checks and the recommended intervals.

When performing tests, adjustments or repairs to the engine, ignition system or fuel system, it is essential to follow the procedures and specifications in Groups 21, 22 and 23 of this manual to ensure satisfactory performance of the 1970 engines.

Before replacing damaged or worn engine components such as, a crankshaft, cylinder heads, valve guides, valves, camshafts and cylinder block, be sure the part(s) are not repairable. Recommended repairs covered in Section 2 of this part should be followed whenever such repair will not result in a deviation from Ford-recommended specifications, or will not adversely affect the performance, reliability or stability of the engine.

This part covers engine tests, adjustment, and repair procedures. In addition, the cleaning and inspection procedures are covered.

Complete engine approved performance specifications, including engine, ignition and fuel system components, are covered in Part 21-09. Engine assembly and repair specifications are also in Part 21-09.

For engine removal, disassembly, assembly, installation and major repair procedures, refer to the pertinent part of this group.

For quick engine identification, refer to the Safety Certification Decal shown in Fig. 1. The decal is mounted on the left front door lock face panel. Obtain the signified letter or number on the decal then refer to the engine identification chart to determine the engine type and size.

An engine identification tag is also attached to the engine. The symbol code on the identification tag (Fig. 1) identifies each engine for determining parts usage; i.e., engine cubic inch displacement and model year.

The change level and engine code number determine if parts are peculiar to a specific engine. The engine plant codes designates where and when the engine was built. It is imperative that the codes on the engine identification tag be used when ordering parts or making inquiries about the engine. The pertinent codes are shown in the Master Parts Catalog to designate unique parts.

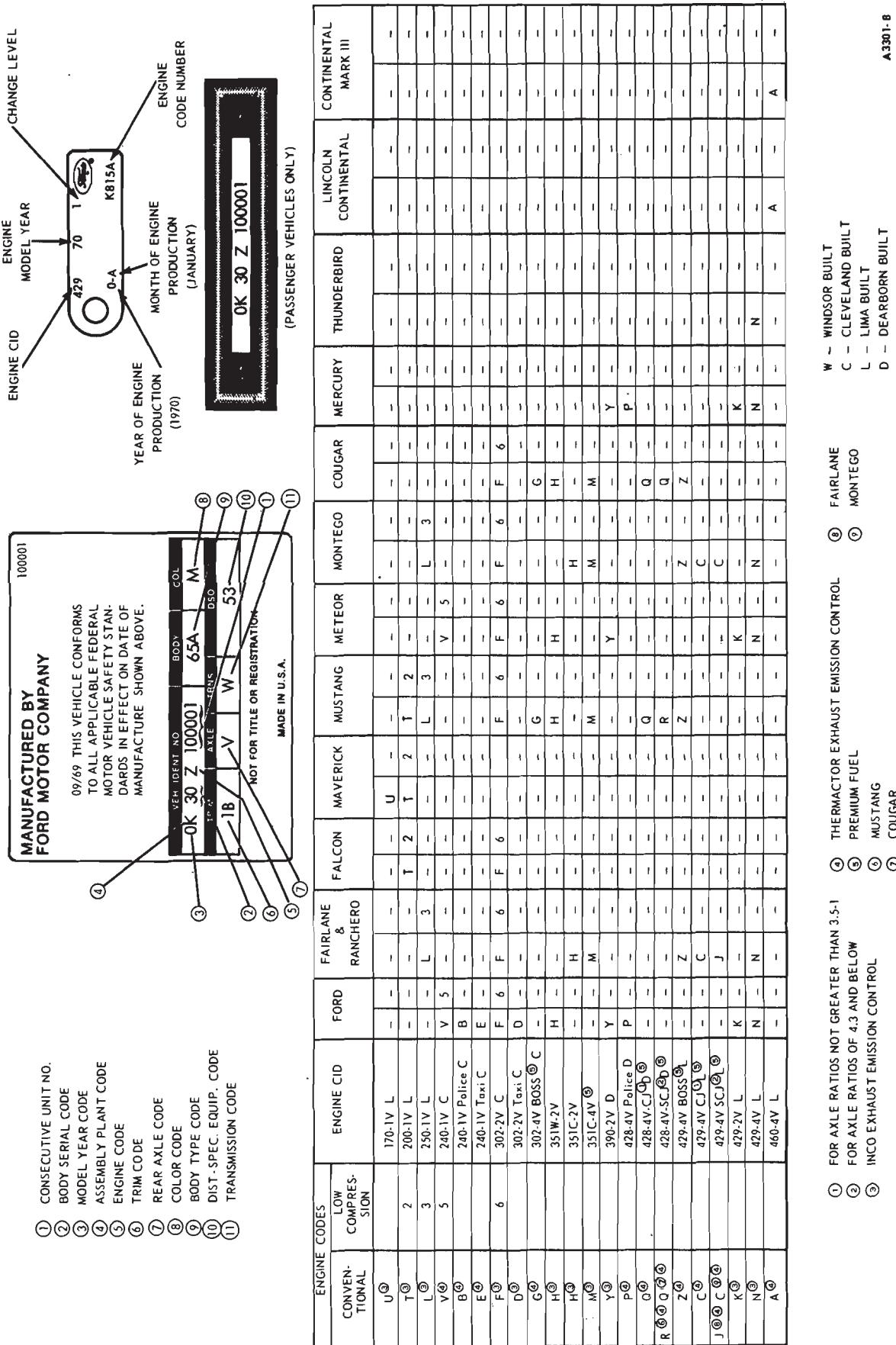


FIG. 1—Engine Identification

## 1 ENGINE TESTS

### CAMSHAFT LOBE LIFT

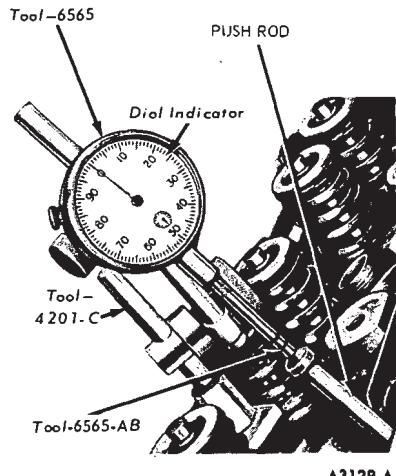
Check the lift of each lobe in consecutive order and make a note of the readings.

1. Remove the air cleaner and the valve rocker arm cover(s).

2. On the rocker shaft mounted rocker arms, remove the valve rocker arm shaft(s) assembly as detailed in the pertinent part.

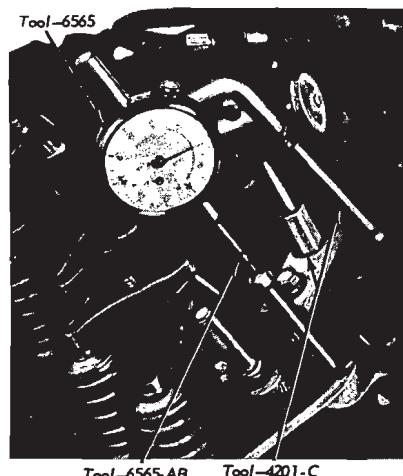
On the stud mounted rocker arms, remove the rocker arm stud nut, (also lock nut on 302 BOSS) fulcrum seat (rocker shaft on 429 BOSS) and rocker arm. Use the adapter for ball-end push rods.

3. Make sure the push rod is in the



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FIG. 2—Testing Camshaft Lobe Lift-Rocker Shaft Mounted Rocker Arms



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FIG. 3—Testing Camshaft Lobe Lift-Stud Mounted Rocker Arms

valve lifter socket. Install a dial indicator in such a manner as to have the ball socket adapter of the indicator on the end of the push rod and in the same plane as the push rod movement (Fig. 2 or 3).

4. Disconnect the brown lead (I terminal) and the red and blue lead (S terminal) at the starter relay. Connect an auxiliary starter switch between the battery and S terminals of the starter relay or solenoid on Thunderbird, Lincoln Continental and Continental Mark III. Crank the engine with the ignition switch OFF.

Bump the crankshaft over until the tappet or lifter is on the base circle of the camshaft lobe. At this point, the push rod will be in its lowest position.

5. Zero the dial indicator. Continue to rotate the crankshaft slowly until the push rod is in the fully raised position (highest indicator reading).

6. Compare the total lift recorded on the indicator with specifications.

7. To check the accuracy of the original indicator reading, continue to rotate the crankshaft until the indicator reads zero. If the lift on any lobe is below specified wear limits, the camshaft and the valve lifters operating on the worn lobe(s) must be replaced.

8. Remove the dial indicator and auxiliary starter switch.

On the rocker shaft type mounted rocker arms, install the rocker arm shaft assembly(ies) as detailed in the specific part for the engine being worked on.

Install the stud mounted rocker arms as detailed in the specific part for the engine being worked on. Adjust the valve clearance as detailed in the pertinent Part.

Do not rotate the crankshaft until the hydraulic valve lifters have had sufficient time to bleed down. Manually bleeding down will reduce the time requirement. To do otherwise may cause serious valve damage.

9. Install the valve rocker arm cover(s) and the air cleaner.

### MANIFOLD VACUUM

A manifold vacuum test aids in determining the condition of an engine and in helping to locate the cause of poor engine performance. To check manifold vacuum:

- Operate the engine for a minimum of 30 minutes at 1200 rpm or until the engine is at normal operating temperature.

- Connect an accurate, sensitive vacuum gauge to the intake manifold vacuum fitting.

- Operate the engine at the recommended idle rpm, with the transmission selector lever in neutral.

- Check the vacuum reading on the gauge.

### TEST CONCLUSIONS

Manifold vacuum is affected by the carburetor adjustment, valve timing, ignition timing, condition of the valves, cylinder compression, condition of the positive crankcase ventilation system and leakage of the manifold, carburetor, carburetor spacer or cylinder head gaskets.

Because abnormal gauge readings may indicate that more than one of the above factors are at fault, exercise caution in analyzing an abnormal reading. For example, if the vacuum is low, the correction of one item may increase the vacuum enough so as to indicate that the trouble has been corrected. It is important, therefore, that each cause of an abnormal reading be investigated and further tests conducted, where necessary, to arrive at the correct diagnosis of the trouble.

Fig 4, lists various types of readings and their possible causes.

Allowance should be made for the effect of altitude on the gauge reading. The engine vacuum will decrease with an increase in altitude.

### COMPRESSION TEST

#### COMPRESSION GAUGE CHECK

- Be sure the crankcase oil is at the proper level and the battery is properly charged. Operate the engine for a minimum of 30 minutes at 1200 rpm or until the engine is at normal operating temperature. Turn the ignition switch off; then remove all the spark plugs.

- Set the carburetor throttle plates in the wide open position.

- Install a compression gauge in No. 1 cylinder.

- Disconnect the brown lead (I terminal) and the red and blue lead (S terminal) at the starter relay or solen-

Gauge Reading	Engine Condition
12 or over - 302 BOSS 15 inches or over 240 I-V Six 429 BOSS 16 or over 302-2V 17 inches or over 170 - 200 I-V Six 250 I-V Six 35 1/2 C2 and 4 V-V8 390 2 and 4 V-V8 428-4V-V8 429 2V-4V 460-4V-V8 18 or over 351 2V and 4V  NOTE—Engines equipped with dual diaphragm distributors, idle vacuum will be approximately 1 inch less.	NORMAL
Low and steady.	Loss of power in all cylinders possibly caused by late ignition or valve timing, or loss of compression due to leakage around the piston rings.
Very low.	Intake manifold, carburetor, spacer or cylinder head gasket leak.
Needle fluctuates steadily as speed increases.	A partial or complete loss of power in one or more cylinders caused by a leaking valve, cylinder head or intake manifold gasket, a defect in the ignition system, or a weak valve spring.
Gradual drop in reading at engine idle.	Excessive back pressure in the exhaust system.
Intermittent fluctuation.	An occasional loss of power possibly caused by a defect in the ignition system or a sticking valve.
Slow fluctuation or drifting of the needle.	Improper idel mixture adjustment or carburetor, spacer or intake manifold gasket leak, or restricted crankcase ventilation system.

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FIG. 4—Manifold Vacuum Gauge Readings

oid on the Thunderbird, Lincoln Continental or Continental Mark III. Install an auxiliary starter switch between the battery and S terminals of the starter relay or solenoid. Using the auxiliary starter switch, crank the engine (with the ignition switch off) at least five compression strokes and record the highest reading.

Note the approximate number of compression strokes required to obtain the highest reading.

5. Repeat the test on each cylinder, to obtain the highest reading on the No. 1 cylinder.

#### TEST CONCLUSION

The indicated compression pressures are considered normal if the lowest reading cylinder is within 75%

of the highest. Refer to the following example and the Compression Pressure Limit Chart.

Seventy-five (75%) percent of 140, the highest cylinder reading is 105. Therefore, cylinder No. 7 being less than 75% of cylinder No. 3 indicates an improperly seated valve or worn or broken piston rings.

If one, or more, cylinders read low, squirt approximately one (1) tablespoon of engine oil on top of the pistons in the low reading cylinders. Repeat compression pressure check on these cylinders.

1. If compression improves considerably, the piston rings are at fault.

2. If compression does not improve, valves are sticking or seating poorly.

3. If two adjacent cylinders indi-

Cylinder No.	Quick Reference
1	134
2	128
3	140
4	127
5	122
6	135
7	100
8	129

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FIG. 5—Example Compression Readings

cate low compression pressures and squirting oil on the pistons does not increase the compression, the cause may be a cylinder head gasket leak between the cylinders. Engine oil and/or coolant in the cylinders could result from this problem.

It is recommended the following quick reference chart be used when checking cylinder compression pressures. The chart has been calculated so that the lowest reading number is 75% of the highest reading.

After checking the compression pressures in all cylinders, it was found that the highest reading obtained was 196 psi. The lowest pressure reading was 155 psi. By locating 196 in the maximum column it is seen that the lowest allowable pressure is 147 psi. Since the lowest cylinder reading was 155 psi. The engine is within specifications and the compression is considered satisfactory.

#### HYDRAULIC VALVE LIFTER

Hydraulic valve lifter noise may be caused by improper operating clearance as a result of loose adjusting nuts or improper initial adjustment. Always check rocker arm to valve stem clearance before condemning or replacing a valve lifter.

Dirt, deposits of gum and varnish and air bubbles in the lubricating oil can cause hydraulic valve lifter failure or malfunction.

Dirt, gum and varnish can keep a check valve from seating and cause a loss of hydraulic pressure. An open valve disc will cause the plunger to force oil back into the valve lifter reservoir during the time the push rod is being lifted to force the valve from its seat.

Air bubbles in the lubricating system can be caused by too much oil in the system or too low an oil level. Air may also be drawn into the lubricat-

## COMPRESSION PRESSURE LIMITS

Maximum PSI	Minimum PSI	Maximum PSI	Minimum PSI	Maximum PSI	Minimum PSI
134	101	174	131	214	160
136	102	176	132	216	162
138	104	178	133	218	163
140	105	180	135	220	165
142	107	182	136	222	166
144	108	184	138	224	168
146	110	186	140	226	169
148	111	188	141	228	171
150	113	190	142	230	172
152	114	192	144	232	174
154	115	194	145	234	175
156	117	196	147	236	177
158	118	198	148	238	178
160	120	200	150	240	180
162	121	202	151	242	181
164	123	204	153	244	183
166	124	206	154	246	184
168	126	208	156	248	186
170	127	210	157	250	187
172	129	212	158		

FIG. 6—Quick Reference Compression Pressure Limit Chart

CA1005-A

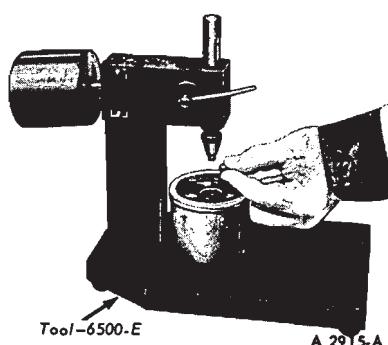


FIG. 7—Placing Steel Ball in Valve Lifter Plunger

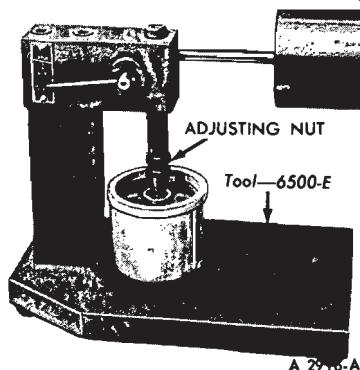


FIG. 8—Adjusting the Ram Length

ing system through an opening in a damaged oil pick-up tube. Air in the hydraulic system will cause a loss of hydraulic pressure.

Assembled valve lifters can be tested with tool 6500-E to check the leak down rate. The leak down rate specification (Part 21-09) is the time in seconds for the plunger to move the length (Part 21-09) of its travel while under a 50 lb load. Test the valve lifters as follows:

1. Disassemble and clean the lifter to remove all traces of engine oil. Lifters cannot be checked with engine oil in them. Only the testing fluid can be used.

2. Place the valve lifter in the tester, with the plunger facing upward. Pour hydraulic tester fluid into the cup to a level that will cover the valve lifter assembly. The fluid can be purchased from the manufacturer of the tester. Do not use kerosene or any other fluid for they will not provide an accurate test.

3. Place a 5/16-inch steel ball in the plunger cap (Fig. 7).

4. Adjust the length of the ram (Fig. 8) so that the pointer is 1/16 inch below the starting mark when the ram contacts the valve lifter plunger, to facilitate timing as the pointer passes the Start Timing mark.

Use the center mark on the pointer scale as the Stop Timing point instead of the original Stop Timing mark at the top of the scale.

5. Work the valve lifter plunger up and down until the lifter fills with fluid and all traces of air bubbles have disappeared.

6. Allow the ram and weight to force the valve lifter plunger downward. Measure the exact time it takes for the pointer to travel from the Start Timing to the Stop Timing marks of the tester.

7. A valve lifter that is satisfactory must have a leak-down rate (time in seconds) within the minimum and maximum limits specified.

8. If the valve lifter is not within specifications, replace it with a new lifter. It is not necessary to disassemble and clean new valve lifters before testing, because the oil contained in new lifters is test fluid.

9. Remove the fluid from the cup and bleed the fluid from the lifter by working the plunger up and down. This step will aid in depressing the lifter plungers when checking the valve clearance.

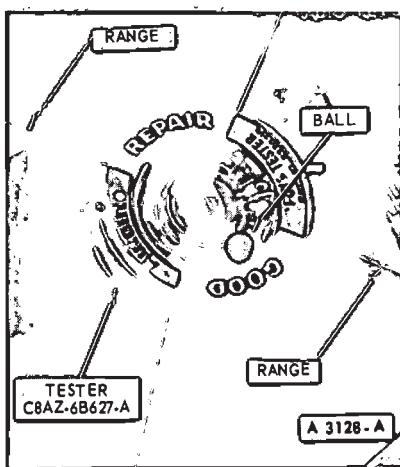
## POSITIVE CLOSED-TYPE VENTILATION SYSTEM

A malfunctioning closed crankcase ventilation system may be indicated by loping or rough engine idle. Do not attempt to compensate for this idle condition by disconnecting the crankcase ventilation system and making carburetor adjustments. The removal of the crankcase ventilation system from the engine will adversely affect the fuel economy and engine ventilation with resultant shortening of engine life.

To determine whether the loping or rough idle condition is caused by a malfunctioning crankcase ventilation system, perform either of the following tests.

## AIR INTAKE TEST

This test is performed with the crankcase ventilation tester C8AZ-6B627-A (Fig. 9) which is operated by the engine vacuum through the oil fill opening. Follow the procedures described below to install the tester and check the crankcase ventilation sys-



**FIG. 9—Crankcase Ventilation System Tester**

tem for faulty operation.

1. With the engine at normal operating temperature, remove the oil filler cap.

2. Hold the tester C8AZ-6B627-A over the opening in the valve cover. Make sure that the surface is flat to form a seal between the cover and tester. If the cover is distorted, shape it as required to make an air tight seal. An air leak between the cover and tester will render the tester inoperative.

3. Start the engine and allow it to operate at the recommended idle speed.

4. Hold the tester over the oil filler cap opening making sure that there is a positive seal between the tester and cover.

5. If the ball settles in the **Good** (green) area, the system is functioning properly. If the ball settles in the **Repair** (red) area, clean or replace the malfunctioning components as required.

6. Repeat the test after repairs are made to make sure that the crankcase ventilation system is operating satisfactorily.

Clean or replace the malfunctioning components as required. Repeat the test to ensure that the crankcase ventilation system is operating satisfactorily.

#### CRANKCASE VENTILATION REGULATOR VALVE TEST

Install a known good regulator valve in the crankcase ventilation system.

Start the engine and compare the engine idle condition to the prior idle condition.

If the idle condition is found to be satisfactory, replace the regulator valve and clean the hoses, fittings, etc.

If the loping or rough idle condition remains when the good regulator valve is installed, the crankcase ventilation regulator valve is not at fault. Check the crankcase ventilation system for restriction at the intake manifold or carburetor spacer. If the system is not restricted, further engine component diagnosis will have to be conducted to find the malfunction.

#### THERMACTOR EXHAUST EMISSION CONTROL SYSTEM

The following procedures are recommended for checking and/or verifying that the various components of the Thermactor exhaust emission control system are operating properly. The engine and all components must be at normal operating temperatures when the tests are performed.

Prior to performing any extensive test or diagnosis of the Thermactor system, verify that the problem exists, then it must be determined that the engine as a unit is functioning properly. Disconnect the air bypass valve vacuum sensing line at the intake manifold. Plug the manifold connection to preclude leakage. Normal engine diagnosis procedures can then be performed.

#### AIR SUPPLY PUMP TEST

1. Assemble a test gauge adapter as shown in Fig. 10), and install a fuel pump test gauge on the adapter. The test gauge used must be accurate and readable in 1/4 psi increments.

2. Operate the engine until it reaches normal operating temperature.

3. Inspect all hoses and hose connections for leaks and correct as necessary before checking the air supply pump.

4. Check the air pump belt tension and adjust to specifications.

5. Disconnect the air supply hose(s) at the air manifold check valve(s). If there are two check valves, close off one hose by inserting a suitable plug in the end of the hose. Use a hose clamp and secure the plug so it will not blow out.

6. Insert the open pipe end of the test gauge adapter in the other air supply hose. Clamp the hose securely to the adapter to prevent it from blowing out.

Position the adapter and test gauge so that the air blast emitted through

the drilled pipe plug will be harmlessly dissipated.

7. Install a tachometer on the engine. Start the engine and slowly increase the engine speed to 1500 rpm. Observe the pressure produced at the test gauge. The air pressure should be one (1) psi or more.

8. If the air pressure does not meet or surpass the above pressure, disconnect and plug the air supply hose to the air bypass valve. Clamp the plug in place, and repeat the pressure test.

If the air pump pressure still doesn't meet the minimum requirements, install a new air pump and repeat the pump test. Replace the air pump as determined by the result of this test.

#### CHECK VALVE TEST

This test can be performed at the same time as the Air Pump Test.

1. Operate the engine until it reaches normal operating temperature.

2. Inspect all hoses and hose connections for obvious leaks and correct as necessary before checking the check valve operation.

3. Disconnect the air supply hose(s) at the check valve(s).

4. Visually inspect the position of the valve plate inside the valve body. It should be positioned lightly against the valve seat — away from the air manifold.

5. Insert a probe into the hose connection on the check valve and depress the valve plate. It should freely return to the original position, against the valve seat, when released.

If equipped with two check valve assemblies, check both valves for free operation.

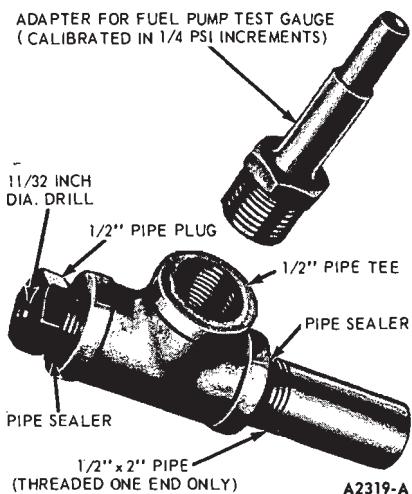
6. Leave the hose(s) disconnected and start the engine. Slowly increase the engine speed to 1500 rpm and watch for exhaust gas leakage at the check valve(s). There should not be any exhaust leakage. The valve may flutter or vibrate at idle speeds, but this is normal due to the exhaust pulsations in the manifold.

7. If the check valve(s) does not meet the recommended conditions (steps 4, 5 and 6), replace it.

#### AIR BYPASS VALVE FUNCTIONAL TEST

Determine if the air bypass valve (Fig. 11) is functioning properly by performing the following operation(s):

1. Remove the air bypass valve to air manifold check valve hose at the



**FIG. 10—Air Supply Pump Test Gauge Adapter**

bypass valve hose connection.

2. With the transmission in neutral and the parking brake ON, start the engine and operate at normal engine idle speed. Verify that air is flowing from the air bypass valve hose connection. Air pressure should be noted as this is the normal delivery flow to the air manifold(s).

3. Momentarily (approximately 5 seconds) pinch off the vacuum hose to the bypass valve to duplicate the air bypass cycle.

4. Release the pinched vacuum hose. Air flow through the air bypass valve should diminish or stop for a short period of time. The length of time required to resume normal flow cannot be specified since the time interval is dependent on engine vacuum and length of time the vacuum line is pinched off.

#### DIAPHRAGM LEAKAGE CHECK

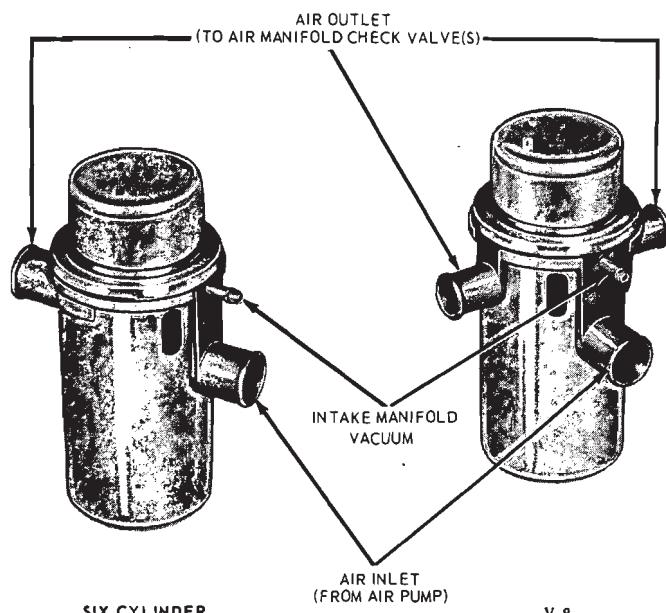
Evaluate the bypass valve for diaphragm leakage by performing the following check:

1. Remove the vacuum supply hose from the air bypass valve at the bypass valve connection.

2. Insert a tee connection in the vacuum supply hose. Connect a vacuum gauge to one of the remaining hose connections on the tee, insert a short length of hose (approximately 3 inches) on the remaining connection. Insert a suitable plug in the open end of the short length of hose.

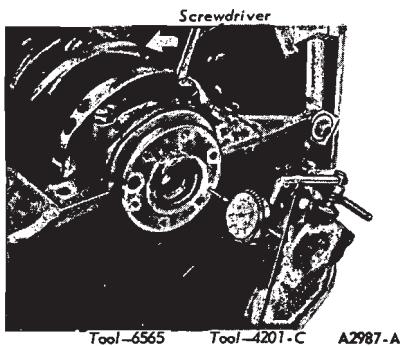
3. Start the engine and note the vacuum gauge reading.

4. Remove the plug from the short length of hose and connect to the air bypass valve vacuum connection. Ob-



**FIG. 11—Thermactor Air Bypass Valves**

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**FIG. 12—Checking Crankshaft End Play**

serve vacuum gauge reading. If the indicated vacuum reading does not correspond with the previous reading after approximately 60 seconds, replace the air bypass valve.

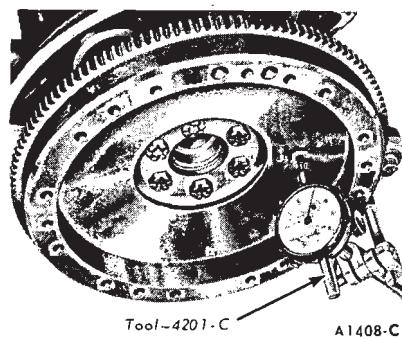
#### CRANKSHAFT END PLAY

1. Force the crankshaft toward the rear of the engine.

2. Install a dial indicator so that the contact point rests against the crankshaft flange and the indicator axis is parallel to the crankshaft axis (Fig. 12).

3. Zero the dial indicator. Push the crankshaft forward and note the reading on the dial.

4. If the end play exceeds the wear limit, replace the thrust bearing. If the end play is less than the minimum limit inspect the thrust bearing faces for scratches, burrs, nicks, or dirt. If



**FIG. 13—Checking Flywheel Face Runout**

the thrust faces are not damaged or dirty, they probably were not aligned properly. Install the thrust bearing and align the faces following the procedure recommended under Main Bearing Replacement in the pertinent engine section. Check the end play.

#### FLYWHEEL FACE RUNOUT— MANUAL-SHIFT TRANSMISSIONS

Install a dial indicator so that the indicator point bears against the flywheel face (Fig. 13). Turn the flywheel making sure that it is full forward or rearward so that crankshaft end play will not be indicated as flywheel runout.

If the clutch face runout exceeds specifications, remove the flywheel and check for burrs between the flywheel and the face of the crankshaft

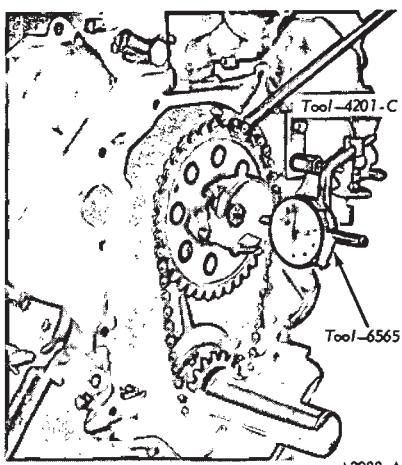


fig. 14—Checking Camshaft End Play—V-8 Engine

mounting flange. If no burrs exist, check the runout of the crankshaft mounting flange. Replace the flywheel or machine the crankshaft-flywheel mounting face sufficiently to true up the surface if the mounting flange runout exceeds specifications, replace it or reinstall it on the flywheel. Refer to Ring Gear Replacement in this Part for the proper procedure.

#### FLYWHEEL RUNOUT—AUTOMATIC TRANSMISSIONS

Remove the spark plugs.

Install a dial indicator so that the indicator point rests on the face of the ring gear adjacent to the gear teeth.

Push the flywheel and crankshaft forward or backward as far as possible to prevent crankshaft end play from being indicated as flywheel runout.

Set the indicator dial on the zero mark. Turn the flywheel one complete revolution while observing the total indicator reading (TIR). If the TIR exceeds specifications, the flywheel and ring gear assembly must be replaced.

#### CAMSHAFT END PLAY

On all V-8 engines, prying against the aluminum-nylon camshaft sprocket, with the valve train load on the camshaft, can break or damage the sprocket. Therefore, the rocker arm adjusting nuts must be backed off, or the rocker arm and shaft assembly must be loosened sufficiently to free the camshaft. After checking the camshaft end play, adjust the valve clearance

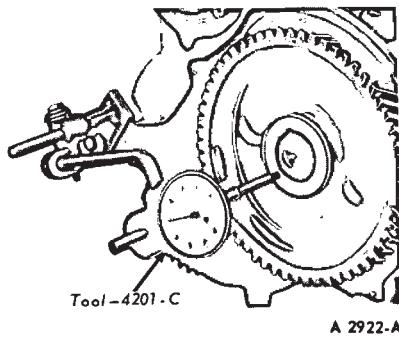


FIG. 15—Checking Camshaft End Play—240 Six

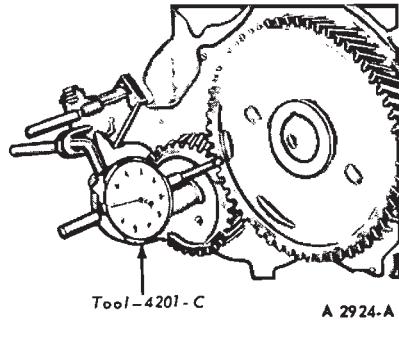


FIG. 17—Checking Timing Gear Runout—240 Six

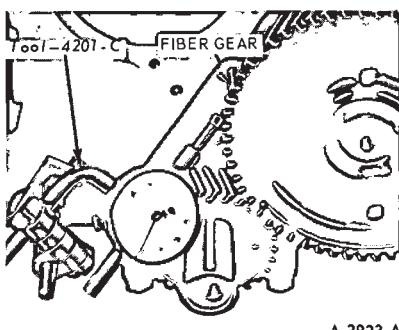


FIG. 16—Checking Timing Gear Backlash—240 Six

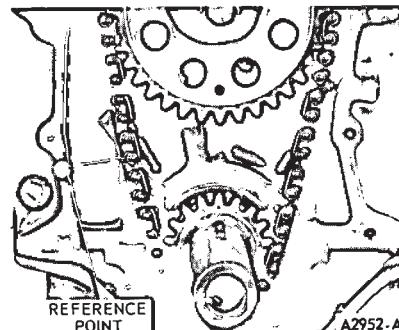


FIG. 18—Checking Timing Chain Deflection—V-8 Engine

Push the camshaft toward the rear of the engine. Install a dial indicator so that the indicator point is on the camshaft sprocket attaching screw (Fig. 14) or gear hub (Fig. 15). Zero the dial indicator. Position a large screwdriver between the camshaft sprocket or gear and the block. Pull the camshaft forward and release it. Compare the dial indicator reading with specifications. If the end play is excessive, replace the thrust plate. If a spacer is used, check the spacer for correct installation before it is removed. If the spacer is correctly installed, replace the thrust plate.

Remove the dial indicator.

#### TIMING GEAR BACKLASH

Install a dial indicator on the cylinder block (Fig. 16). Check the backlash between the camshaft gear and the crankshaft gear with a dial indicator (Fig. 16). Hold the gear firmly against the block while making the check. Refer to the specifications for the backlash limits.

#### TIMING GEAR RUNOUT

Install a dial indicator on the cylinder block as shown in Fig. 17. Hold the camshaft gear against the camshaft thrust plate and zero the in-

dicator. Rotate the crankshaft to turn the camshaft, while holding the camshaft gear against the thrust plate. Check the gear runout through one complete revolution of the camshaft. If the gear runout exceeds specifications, remove it and check for burrs or foreign particles on or between the camshaft and gear joining flanges. Recheck the runout; if it still exceeds specifications, replace the gear.

Follow the above procedure to check crankshaft gear runout.

#### TIMING CHAIN DEFLECTION

1. Rotate the crankshaft in a clockwise direction (as viewed from the front) to take up the slack on the left side of the chain.

2. Establish a reference point on the block and measure from this point to the chain (Fig. 18).

3. Rotate the crankshaft in the opposite direction to take up the slack on the right of the chain. Force the left side of the chain out with the fingers and measure the distance between the reference point and the chain. The deflection is the difference between the two measurements.

If the deflection exceeds specifications, replace the timing chain and sprockets.

## 2 IN-VEHICLE REPAIRS

### REPAIRS

#### VALVE ROCKER ARM AND/OR SHAFT ASSEMBLY

Dress up minor surface defects on the rocker arm shaft and in the rocker arm bore with a hone (170, 200, 250 Six, 390, 428 and 429 BOSS V-8 only).

If the pad at the valve end of the rocker arm has a grooved radius, replace the rocker arm. **Do not attempt to true this surface by grinding.**

Refer to Cylinder Head Repair for the rocker arm stud replacement procedure.

#### PUSH RODS

Following the procedures in Section 3 under Push Rod Inspection, check the push rods for straightness.

If the runout exceeds the maximum limit at any point, discard the rod. **Do not attempt to straighten push rods.**

#### CYLINDER HEADS

Replace the head if it is cracked. **Do not plane or grind more than 0.010 inch from the cylinder head gasket surface.** Remove all burrs or scratches with an oil stone.

#### Rocker Arm Stud Nut Replacement—240 Six and 302 V-8

If the rocker arm stud nut breakaway torque is less than specified, install a new standard stud nut and recheck the breaking torque. Refer to Valve Clearance Adjustment in Part 21-04 for the torque procedure. If working on a 302 BOSS engine, a lock nut is provided to secure the stud nut. Therefore, breaking torque is not applicable and the lock nut must be installed and torqued to specification after the clearance has been established.

#### Rocker Arm Stud Nut Replacement—351, 429 and 460 V-8

Crank the engine to place the cylinder being worked on at approximately TDC. Remove the nut from the stud. With the rocker arm and fulcrum in position on the stud,

thread the nut onto the stud until it contacts the shoulder, then tighten it to specification. Check the valve clearance to make certain that it is within specifications.

#### Rocker Arm Stud Replacement—240 Six, 302 and 351-W V-8

If it is necessary to remove a rocker arm stud, tool kit T62F-6A527-B is available which contains the following: a stud remover, a 0.006-inch oversize reamer, and a 0.015-inch oversize reamer. For 0.010-inch oversize studs, use reamer T66P-6A527-B. To press in replacement studs, use stud replacer T64P-6A527-A on a 240 or 302 engine, and stud replacer T69P-6049-D on a 351 CID engine.

Rocker arm studs that are broken or have damaged threads may be replaced with standard studs. Loose studs in the head may be replaced with 0.006, 0.010 or 0.015-inch oversize studs which are available for service.

Standard and oversize studs can be identified by measuring the stud diameter within 1-1/8 inch from the pilot end of the stud. The stud diameters are:

Standard	...0.3714—0.3721
0.006	oversize...0.3774—0.7781
0.010	oversize...0.3814—0.3821
0.015	oversize...0.3864—0.3871

When going from a standard size rocker arm stud to a 0.010 or 0.015-inch oversize stud, always use the

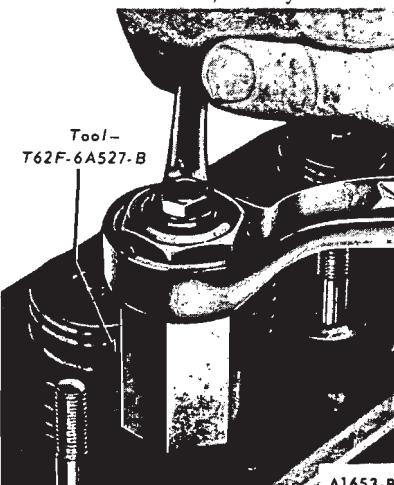


FIG. 19—Removing Rocker Arm Stud—240 Six, 302-W and 351 V-8

0.006-inch oversize reamer before finish reaming with the 0.010 or 0.015-inch oversize reamer.

1. Position the sleeve of the rocker arm stud remover (tool T62F-6A527-B) over the stud with the bearing end down. When working on a 302 or 351 CID cylinder head, cut the threaded part of the stud off with a hack saw. This is necessary due to the puller being designed for 3/8-inch studs and will not grip the 5/16-inch thread on a 302 or 351 CID cylinder head stud. Thread the puller into the sleeve and over the stud until it is fully bottomed. Hold the sleeve with a wrench, then rotate the puller clockwise to remove the stud (Fig. 19).

If the rocker arm stud was broken off flush with the stud boss, use an easy-out to remove the broken stud following the instructions of the tool manufacturer.

2. If a loose rocker arm stud is being replaced, ream the stud bore using the proper reamer (or reamers in sequence) for the selected oversize stud (Fig. 20). **Make sure the metal particles do not enter the valve area.**

3. If working on a 240 or 302 CID engine, screw the new stud into the sliding driver of the rocker arm stud installer (T65P-6A527-A) and coat the end of the stud with Lubriplate. Align the stud and installer with the stud bore, then tap the sliding driver until it bottoms (Fig. 21). When the installer contacts the stud boss, the stud is installed to its correct height. This applies to a 240 or 302 engine.

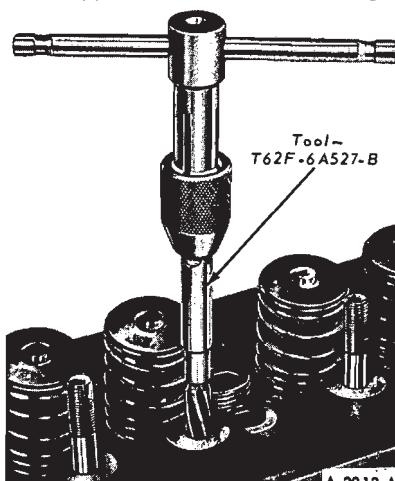


FIG. 20—Reaming Rocker Arm Stud Bore—240 Six, 302-W and 351 V-8

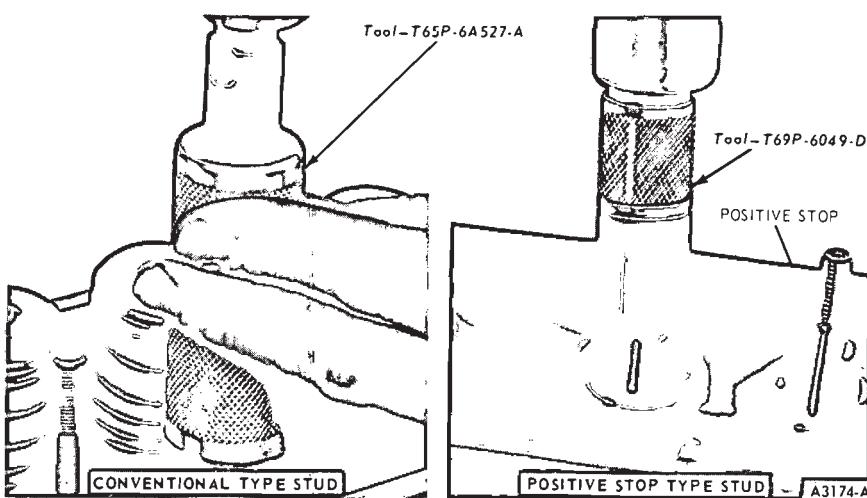


FIG. 21—Installing Rocker Arm Stud—240 Six, 302-W and 351 V-8

only.

4. Use tool T69P-6049-D when installing a positive stop stud (Fig. 21) in a 351 CID cylinder head.

#### Rocker Arm Stud Replacement—302 BOSS, 429 and 460 V-8

1. Position the piston of the cylinder being worked on at TDC.
2. Remove the nut (and lock nut 302 BOSS) fulcrum and rocker arm.
3. Inspect the push rod for wear and replace as required.
4. Thread the new stud into the cylinder head until the shoulder contacts the head (push rod guide plate 302 BOSS). Then, torque it to specifications.
5. Lubricate the rocker arm components.
6. Position the rocker arm and fulcrum on the stud. Thread the nut onto the stud until it contacts the shoulder, then tighten it to specification.
7. Check the valve clearance to make certain that it is within specification.

#### Reaming Valve Guides

If it becomes necessary to ream a valve guide (Fig. 22) to install a valve with an oversize stem, a reaming kit is available which contains the following reamer and pilot combinations: a 0.003-inch OS reamer with a standard diameter pilot, a 0.015-inch OS reamer with a 0.003-inch OS pilot, and a 0.030-inch reamer with a 0.015-inch OS pilot.

When going from a standard size valve to an oversize valve always use the reamer in sequence. Always reface

the valve seat after the valve guide has been reamed, and use a suitable scraper to break the sharp corner (ID) at the top of the valve guide.

#### Refacing Valve Seats

Refacing of the valve seat should be closely coordinated with the refacing of the valve face so that the finished seat and valve face will be concentric and the specified interference fit will be maintained. This is important so that the valve and seat will have a compression-tight fit. Be sure that the refacer grinding wheels are properly dressed.

Grind the valve seats of all engines to a true 45 degree angle (Fig. 23). Remove only enough stock to clean up pits and grooves or to correct the valve seat runout. After the seat has been refaced, use a seat width scale or a machinist scale to measure the seat width (Fig. 24). Narrow the seat, if necessary to bring it within specifications.

If the valve seat width exceeds the maximum limit, remove enough stock from the top edge and/or bottom edge of the seat to reduce the width to specifications.

On the valve seats of all engines use a 60 degree angle grinding wheel to remove stock from the bottom of the seats (raise the seats) and use a 30 degree angle wheel to remove stock from the top of the seats (lower the seats).

The finished valve seat should contact the approximate center of the valve face. It is good practice to determine where the valve seat contacts the face. To do this, coat the seat with Prussian blue and set the valve in place. Rotate the valve with light

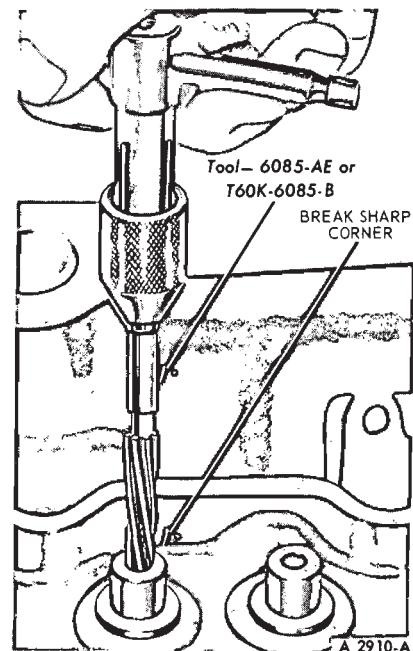


FIG. 22—Reaming Valve Guides

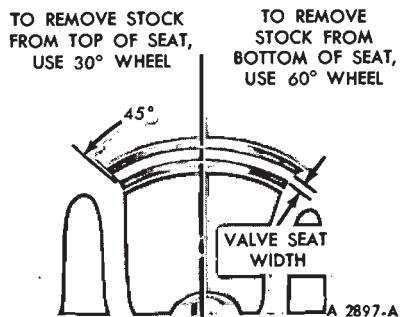


FIG. 23—Refacing Valve Seat

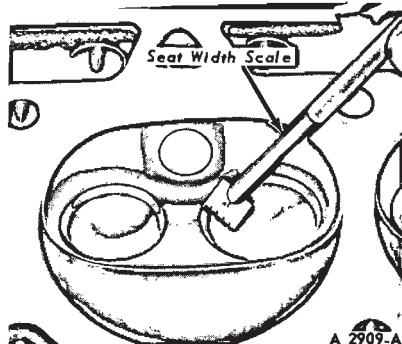


FIG. 24—Checking Valve Seat Width

pressure. If the blue is transferred to the center of the valve face, the contact is satisfactory. If the blue is transferred to the top edge of the valve face, lower the valve seat. If the blue is transferred to the bottom edge of the valve face, raise the valve seat.

## VALVES

For inspection procedures refer to Section 3.

Minor pits, grooves, etc., may be removed. Discard valves that are severely damaged, or if the face runout or stem clearance exceeds specifications.

Discard any worn or damaged valve train parts.

## Refacing Valves

The valve refacing operation should be closely coordinated with the valve seat refacing operations so that the finished angles of the valve face and of the valve seat will be to specifications and provide a compression-tight fit. Be sure that the refacer grinding wheels are properly dressed.

If the valve face runout is excessive and/or to remove pits and grooves, reface the valves to a true 44 degree angle. Remove only enough stock to correct the runout or to clean up the pits and grooves. If the edge of the valve head is less than 1/32 inch thick after grinding, replace the valve as the valve will run too hot in the engine. **The interference fit of the valve and seat should not be lapped out.**

Remove all grooves or score marks from the end of the valve stem, and chamfer it as necessary. Do not remove more than 0.010 inch from the end of the valve stem. **The valve stem from the valve lock groove to the end (Fig. 39), must not be shorter than the minimum specified length.**

If the valve and/or valve seat has been refaced, it will be necessary to check the clearance between the rock-

er arm pad and the valve stem with the valve train assembly installed in the engine.

## Select Fitting Valves

If the valve stem to valve guide clearance exceeds the wear limit, ream the valve guide for the next oversize valve stem. Valves with oversize stem diameters of 0.003, 0.015 and 0.030 inch are available for service. Always reface the valve seat after the valve guide has been reamed. Refer to Reaming Valve Guides.

## CAMSHAFT

Remove light scuffs, scores or nicks from the camshaft machined surfaces with a smooth oil stone.

## CRANKSHAFT

Dress minor scores with an oil stone. If the journals are severely marred or exceed the wear limit, they should be refinished to size for the next undersize bearing.

## Refinishing Journals

Refinish the journals to give the proper clearance with the next undersize bearing. If the journal will not clean up to maximum undersize bearing available, replace the crankshaft.

Always reproduce the same journal shoulder radius that existed originally. Too small a radius will result in fatigue failure of the crankshaft. Too large a radius will result in bearing failure due to radius ride of the bearing.

After refinishing the journals, chamfer the oil holes; then polish the journal with a No. 320 grit polishing cloth and engine oil. Crocus cloth may also be used as a polishing agent.

## FITTING MAIN OR CONNECTING ROD BEARINGS

**1. Clean crankshaft journals. Inspect journals and thrust faces (thrust bearing) for nicks, burrs or bearing pick-up that would cause premature bearing wear. When replacing standard bearings with new bearings, it is good practice to fit the bearing to minimum specified clearance. If the desired clearance cannot be obtained with a standard bearing, try one half of a 0.001 or 0.002 inch undersize in combination with a standard bearing**

to obtain the proper clearance.

**2. If fitting a main bearing, position a jack under counterweight adjoining bearing which is being checked. Support crankshaft with jack so its weight will not compress Plastigage and provide an erroneous reading.**

**3. Place a piece of Plastigage on bearing surface across full width of bearing cap and about 1/4 inch off center (Fig. 25).**

**4. Install cap and torque bolts to specifications. Do not turn crankshaft while Plastigage is in place.**

**5. Remove cap. Using Plastigage scale, check width of Plastigage at widest point to get minimum clearance. Check at narrowest point to get maximum clearance. Difference between readings is taper of journals.**

**6. If clearance exceeds specified limits, try 0.001 or 0.002 inch undersize bearings in combination with the standard bearings. Bearing clearance must be within specified limits. If 0.002 undersize main bearings are used on more than one journal, be sure they are all installed in cylinder block side of bearing. If standard and 0.002 inch undersize bearings do not bring clearance within desired limits, refinish crankshaft journal, then install undersize bearings.**

**7. After bearing has been fitted, apply light coat of engine oil to journal and bearings. Install bearing cap. Torque cap bolts to specifications.**

**8. Repeat procedure for remaining bearings that require replacement.**

## PISTONS, PINS AND RINGS

### PISTONS, PINS AND RINGS Fitting Pistons

Pistons are available for service in standard sizes and the oversizes shown in Fig. 28.

The standard-size pistons are color coded red on the dome. Refer to the specifications for standard-size piston dimensions. Piston pins and retainers are provided with new pistons on 390 and 428 V-8 engines. Retainers are not used on all other engines.

Follow the procedures in Section 3 to measure the piston OD and cylinder bore. The dimensions should be within specifications, and the piston to bore clearance (bore ID minus piston OD) must be within the specified limits.

If the clearance is greater than the maximum limit, recheck calculations to be sure that the proper size piston has been selected, check for a dam-

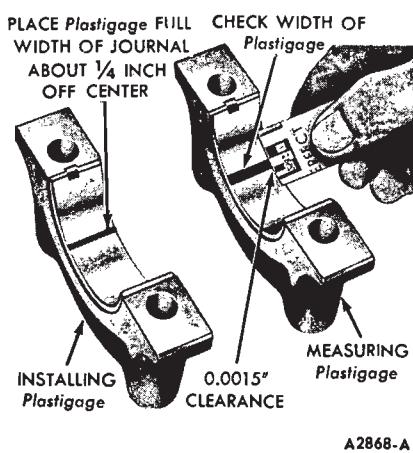


FIG. 25—Installing and Measuring Plastigage—Engine Installed

Engine	Piston Oversize (Inch)
Six 170	0.003, 0.020, 0.030, 0.040 and 0.060
Six 200, 240, 250	0.003, 0.020, 0.030 and 0.040
V-8 302, 351, 390, 428, 429, 460	0.003, 0.020, 0.030 and 0.040

CA1025-A

FIG. 26—Oversize Service Pistons

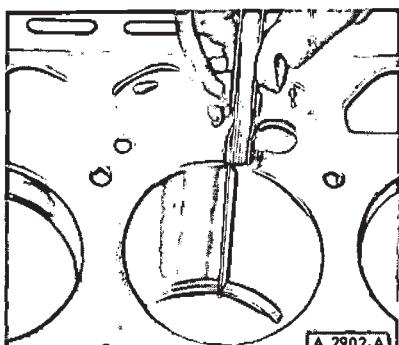


FIG. 27—Checking Piston Ring Gap

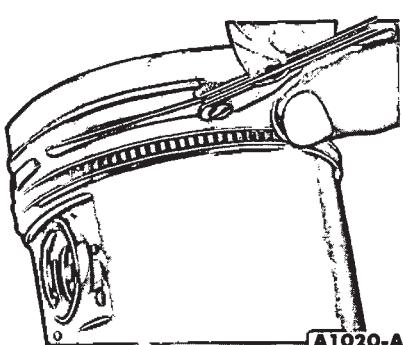


FIG. 28—Checking Piston Ring Side Clearance

aged piston; then try a new piston.

If the clearance is less than the minimum limit, recheck calculations before trying another piston. If none can be fitted, refinish the cylinder to provide the proper clearance for the piston.

When a piston has been fitted, mark it for assembly in the cylinder to which it was fitted.

If the taper, out-of-round and piston to cylinder bore clearance conditions of the cylinder bore are within specified limits, new piston rings will give satisfactory service. If new rings are to be installed in a used cylinder that has not been refinished, remove the cylinder wall glaze (Refer to Cylinder Block, Refinishing Cylinder Walls). Be sure to clean the cylinder bore thoroughly, following the procedure in Section 3.

#### To Fit A Piston:

- Calculate the size piston to be used by taking a cylinder bore check. Follow the procedures outlined in Section 3.

- Select the proper size piston to provide the desired clearance (refer to the specifications). Measure the piston diameter in line with the centerline of the piston pin and at 90 de-

grees to the piston pin axis.

- Make sure the piston and cylinder block are at room temperature (70 degrees F.). After any refinishing operation allow the cylinder bore to cool, and make sure the piston and bore are clean and dry before the piston fit is checked.

#### Fitting Piston Rings

- Select the proper ring set for the size cylinder bore.

- Position the ring in the cylinder bore in which it is going to be used.

- Push the ring down into the bore area where normal ring wear is not encountered.

- Use the head of a piston to position the ring in the bore so that the ring is square with the cylinder wall. Use caution to avoid damage to the ring or cylinder bore.

- Measure the gap between the ends of the ring with a feeler gauge (Fig. 27). If the ring gap is less or greater than the specified limits, try another ring set.

- Check the ring side clearance of the compression rings with a feeler gauge inserted between the ring and its lower land (Fig. 28). The gauge should slide freely around the entire ring circumference without binding.

Any wear that occurs will form a step at the inner portion of the lower land. If the lower lands have high steps, the piston should be replaced.

#### Fitting Piston Pins—390 and 428 V-8

The piston pin should be a light thumb press fit at normal temperature (70 degrees F.). Standard piston pins are color coded green. Pins of 0.001-inch oversize (color coded blue) and 0.002-inch oversize (color coded yellow) are available.

Install the piston pin in the piston and rod. Install a new retainer at each end of the pin to hold it in place. Make sure the retainers are properly seated in their grooves.

If the pin hole in the piston must be reamed or honed on the 390 or 428 V-8 use precision honing equipment or an expansion-type, piloted reamer. Piston pin bores must not be reamed with hand-driven reamers. Use motor-driven reamers, but do not exceed the cutting speed (rpm) recommended by the reamer manufacturer.

If a reamer is used, set the reamer to the size of the pin bore; then expand the reamer slightly and trial ream the pin bore. Take a light cut. Use a pilot sleeve of the nearest size to maintain alignment of the bores.

Check the hole size, using the new piston pin. If the bore is small, expand the reamer slightly and make another cut. Repeat the procedure until the proper fit is obtained. Check the piston pin for fit in the respective rod or rod bushing. On the 390 or 428 V-8, if necessary, ream or hone the rod bushing to fit the pin to specifications.

#### Fitting Piston Pins—All Except 390 and 428 V-8

On all engines except 390 and 428 V-8, install the piston pin, following the procedure under Piston Assembly (Parts 21-02, 21-04, 21-05, 21-06 and 21-08).

#### EXHAUST CONTROL VALVE—240 SIX

##### Removal

- Separate the intake and exhaust manifolds.

- Remove the valve tension spring and the thermostatic spring from the exhaust control valve shaft (Fig. 29).

- Remove the stop pin spring from the manifold.

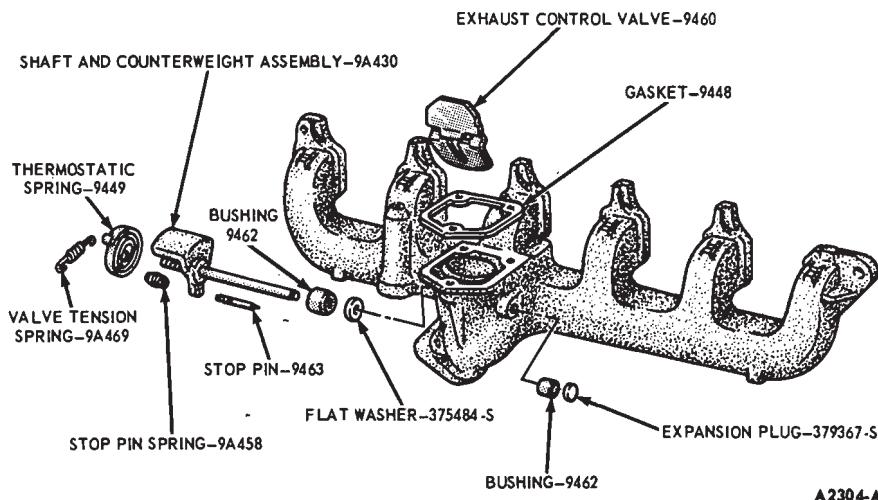


FIG. 29—Exhaust Control Valve Assembly—240 Six

Part Number	Bushing	Outside Diameter of Bushing	Inside Diameter of Bushing Bore in Manifold
(Front — Std.)	C5AZ-9462-A	0.3070-0.3065	0.3061-0.3051
(Rear — Std.)	C5AZ-9462-B	0.6255-0.6250	0.6246-0.6236
(Front — 0.010 O.S.)	C5AZ-9462-C	0.3170-0.3165	0.3161-0.3151
(Rear — 0.010 O.S.)	C5AZ-9462-D	0.6355-0.6350	0.6346-0.6336

Note: Dimensions are in inches.

FIG. 30—Exhaust Control Valve Bushing Sizes—240 Six

CA1026-A

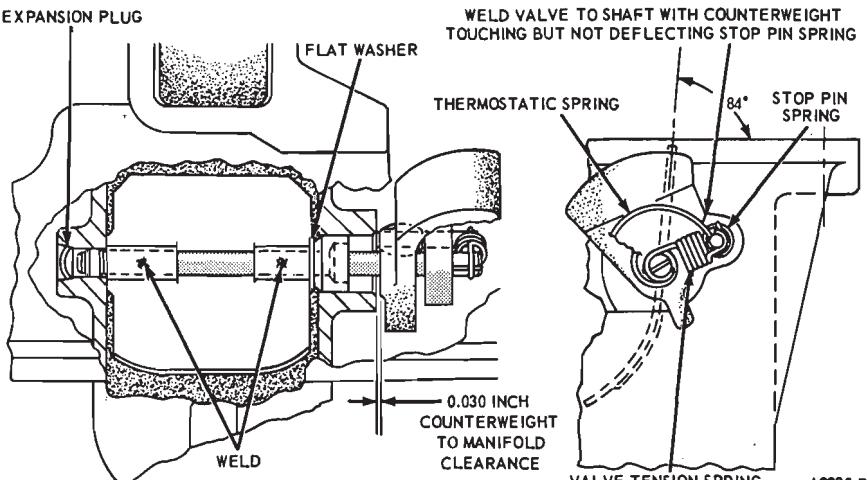


FIG. 31—Valve Plate Position and Counterweight Clearance

4. Using an acetylene torch inside the manifold, cut the shaft on both sides of the valve plate.
5. Remove the valve plate, shaft and flat washer.
6. Remove the expansion plug from the control valve shaft bushing bore.

7. Remove the exhaust control valve bushings from the manifold. These bushings come in two sizes each, both front and rear. To determine which bushings should be used, measure the outside diameter of the removed bushings. Replace with the proper parts (Fig. 30).

## Installation

1. Install the new control valve bushings. The inner end of the smaller bushing should be 0.010-0.015 inch below the inner surface of the exhaust manifold. The inner end of the larger bushing should be 0.020 inch above the inner surface of the exhaust manifold.

2. Ream the bushings to 0.251-0.253 inch ID.

3. Slide the new shaft into the bushings, flat washer and valve plate. The flat washer must be between the valve plate and the large bushing.

4. Install a new stop pin spring on the stop pin.

5. Position the exhaust control valve at an 84 degree angle with the top surface of the manifold (Fig. 31).

6. Rotate the counterweight and shaft assembly clockwise until the counterweight contacts the stop pin spring. Place a 0.030 inch feeler gauge between the counterweight and manifold to maintain the specified clearance while welding.

7. With the plate and counterweight in position, use stainless steel welding rod to tack-weld the valve plate to the shaft.

8. Move the assembly back and forth to check for a binding condition. If there is no binding condition, securely weld the valve plate to the shaft.

9. Install the expansion plug in the manifold bushing bore.

10. Position the new thermostatic spring on the shaft and counterweight assembly so that it will be necessary to wind the spring approximately 1/2 turn in the clockwise direction to hook the open end over the stop pin. Use a 5/16 inch ID piece of tubing to slide the thermostatic spring on the shaft and counterweight assembly. Wind the spring clockwise and hook it over the stop pin.

11. Install a new valve tension spring on the exhaust control valve shaft and the stop pin.

## CYLINDER BLOCK

### Refinishing Cylinder Walls

Honing is recommended for refinishing cylinder walls only when the walls have minor scuffs or scratches, or for fitting pistons to the specified clearance. The grade of hone to be used is determined by the amount of metal to be removed. Follow the instructions of the hone manufacturer.

If coarse stones are used to start the honing operation, leave enough material so that all hone marks can be removed with the finishing hone which is used to obtain the proper piston clearance.

Cylinder walls that are severely marred and/or worn beyond the specified limits should be refinished. Before any cylinder is refinished, all main bearing caps must be in place and tightened to the proper torque so that the crankshaft bearing bores will not become distorted from the refinishing operation.

Refinish only the cylinder or cylinders that require it. All pistons are the same weight, both standard and oversize; therefore, various sizes of pistons can be used without upsetting engine balance.

Refinish the cylinder with the most wear first to determine the maximum oversize. If the cylinder will not clean up when refinished for the maximum oversize piston recommended, replace the block.

Refinish the cylinder to within approximately 0.0015 inch of the required oversized diameter. This will allow enough stock for the final step of honing so that the correct surface finish and pattern are obtained.

For the proper use of the refinishing equipment follow the instructions of the manufacturer. Only experienced personnel should be allowed to

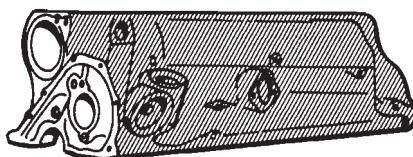
#### perform this work.

Use a motor-driven, spring-pressure-type hone at a speed of 300-500 rpm. Hones of grit sizes 180-220 will normally provide the desired bore surface finish of 15/32 RMS. When honing the cylinder bores use a lubricant mixture of equal parts of kerosene and SAE No. 20 motor oil. Operate the hone in such a way to produce a cross-hatch finish on the cylinder bore. The cross hatch pattern should be at an angle of approximately 30 degrees to the cylinder bore. After the final operation in either of the two refinishing methods described and prior to checking the piston fit, thoroughly clean and oil the cylinder walls, following the procedure in Section 3. Check the piston fit following the procedure in this section and Section 3. Mark the pistons to correspond to the cylinders in which they are to be installed. When the refinishing of all cylinders that require it has been completed and all pistons are fitted, thoroughly clean the entire block and oil the cylinder walls following the procedure under Cylinder Block Cleaning in Section 3.

#### Repairing Engine Castings With Sand Holes or Porosity

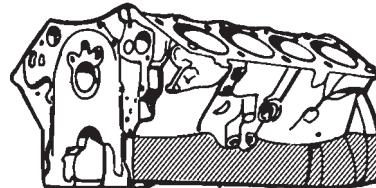
Porosity or sand hole(s) which will cause oil seepage or leakage can occur with modern casting processes.

##### SHADED AREAS MAY BE REPAIRED WITH EPOXY



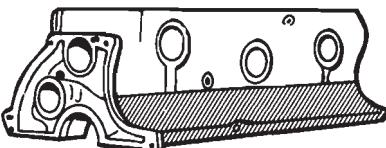
FRONT AND LEFT SIDE

TYPICAL FOR 6-CYLINDER ENGINE

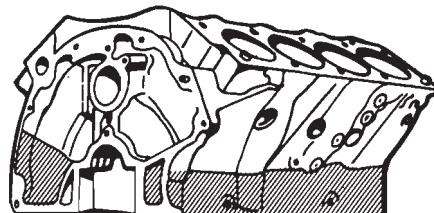


FRONT AND LEFT SIDE

TYPICAL FOR V-8 ENGINE



REAR AND RIGHT SIDE



REAR AND RIGHT SIDE

A2386-B

FIG. 32—Typical Cast Iron Cylinder Block Areas Repairable With Metallic Plastic

A complete inspection of engine and transmission should be made. If the leak is attributed to the porous condition of the cylinder block or sand hole(s), repairs can be made with metallic plastic (part No. C6AZ-19554-A). Do not repair cracks with this material. Repairs with this metallic plastic must be confined to those cast iron engine component surfaces (Fig. 32) where the inner wall surface is not exposed to engine coolant pressure or oil pressure, for example:

1. Cylinder block surfaces extending along the length of the block, upward from the oil pan rail to the cylinder water jacket but not including machined areas.

2. Lower rear face of the cylinder block.

3. Intake manifold casting. Repairs are not recommended to the intake manifold exhaust crossover section, since temperatures can exceed the recommended temperature limit of 500 degrees F.

4. Cylinder front cover on engines using cast iron material.

5. Cylinder head, along the rocker arm cover gasket surface.

The following procedure should be used to repair porous areas or sand holes in cast iron.

1. Clean the surface to be repaired by grinding or rotary filing to a clean bright metal surface. Chamfer or undercut the hole or porosity to a greater depth than the rest of the cleaned surface. Solid metal must surround the hole. Openings larger than 1/4 inch should not be repaired using metallic plastic. Openings in excess of 1/4 inch can be drilled, tapped and plugged using common tools. Clean the repair area thoroughly. Metallic plastic will not stick to a dirty or oily surface.

2. Mix the metallic plastic base and hardener as directed on the container. Stir thoroughly until uniform.

3. Apply the repair mixture with a suitable clean tool, (putty knife, wood spoon, etc.) forcing the epoxy into the hole or porosity.

4. Allow the repair mixture to harden. This can be accomplished by two methods, heat cure with a 250 degree watt lamp placed 10 inches from the repaired surface, or air dry for 10-12 hours at temperatures above 50 degrees F.

5. Sand or grind the repaired area to blend with the general contour of the surrounding surface.

6. Paint the surface to match the rest of the block.

### CORE PLUG REPLACEMENT

To remove a large core plug, drill a 1/2-inch hole in the center of the plug and remove with a clutch pilot bearing puller (tool T59L-100-B and T58L-101-A) or pry it out with a large drift punch. On a small core plug, drill a 1/4-inch hole in the center of the plug and pry it out with a small pin punch. Clean and inspect the plug bore.

Prior to installing a core plug the plug bore should be inspected for any damage that would interfere with the proper sealing of the plug. If the bore is damaged it will be necessary to true the surface by boring for the next specified oversize plug.

Oversize (OS) plugs are identified by the OS stamped in the flat located on the cup side of the plug.

Coat the plug and/or bore lightly with an oil-resistant (oil galley) or water-resistant (cooling jacket) sealer and install it following the procedure for cup type or expansion type below:

#### Cup Type

Cup-type core plugs (Fig. 33) are installed with the flanged edge outward. The maximum diameter of this plug is located at the outer edge of the flange. The flange on cup-type plugs flares outward with the largest diameter at the outer (sealing) edge.

**It is imperative to pull the plug into the machined bore using a properly designed tool.** Under no circumstances is the plug to be driven into the bore using a tool that contacts the flange. This method will damage the sealing edge and will result in leakage and/or plug blow out.

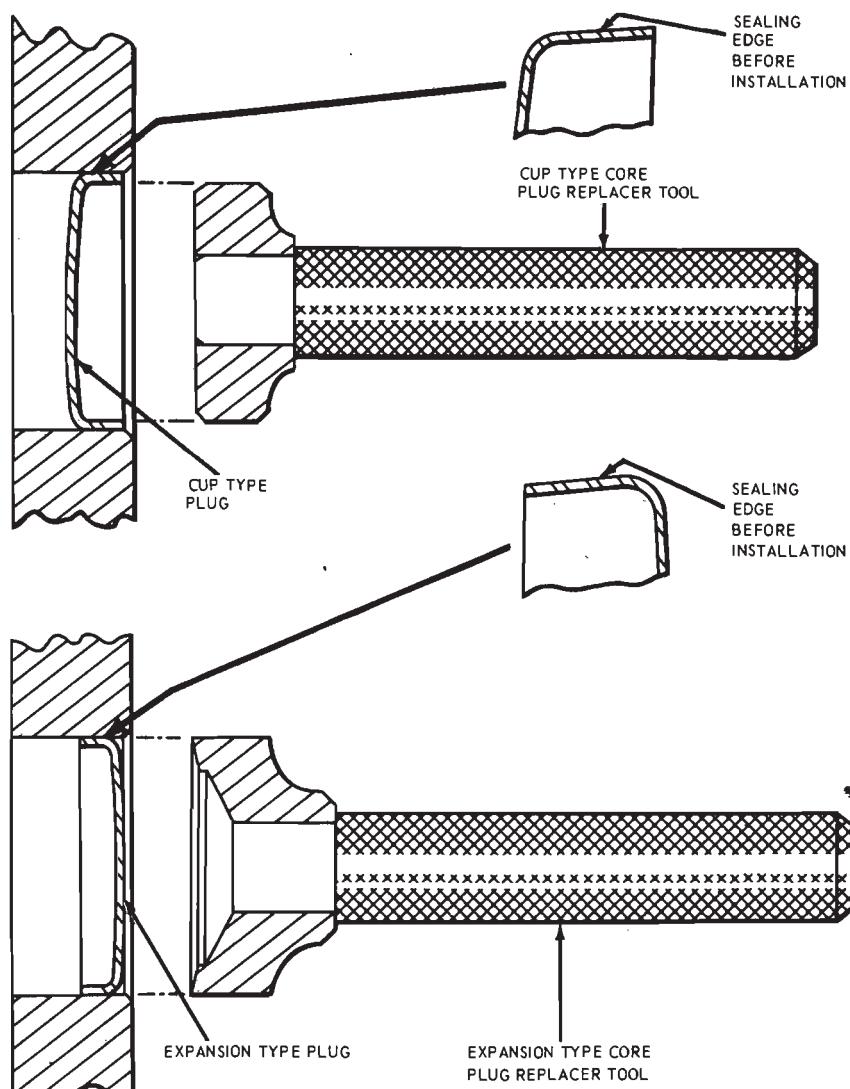
The flanged (trailing) edge must be below the chamfered edge of the bore to effectively seal the plugged bore.

**If the core plug replacing tool has a depth seating surface, do not seat the tool against a non-machined (casting) surface.**

#### Expansion Type

Expansion-type core plugs (Fig. 33) are installed with the flanged edge inward. The maximum diameter of this plug is located at the base of the flange with the flange flaring inward.

**It is imperative to push or drive the plug into the machined bore using a properly designed tool.** Under no circumstances is the plug to be driven using a tool that contacts the crowned portion of the plug. This method will expand the plug prior to installation



A 2735 - B

**FIG. 33—Typical Core Plugs and Installation Tools**

and may damage the plug and/or plug bore.

When installed the trailing (maximum) diameter must be below the chamfered edge of the bore to effectively seal the plugged bore.

**If the core plug replacing tool has a depth seating surface, do not seat the tool against a non-machined (casting) surface.**

#### FLYWHEEL RING GEAR— MANUAL-SHIFT TRANSMISSION

To replace a damaged or worn ring gear, heat the ring gear with a blow torch on the engine side of the gear, and knock it off the flywheel. **Do not hit the flywheel when removing the ring gear.**

Heat the new ring gear evenly until

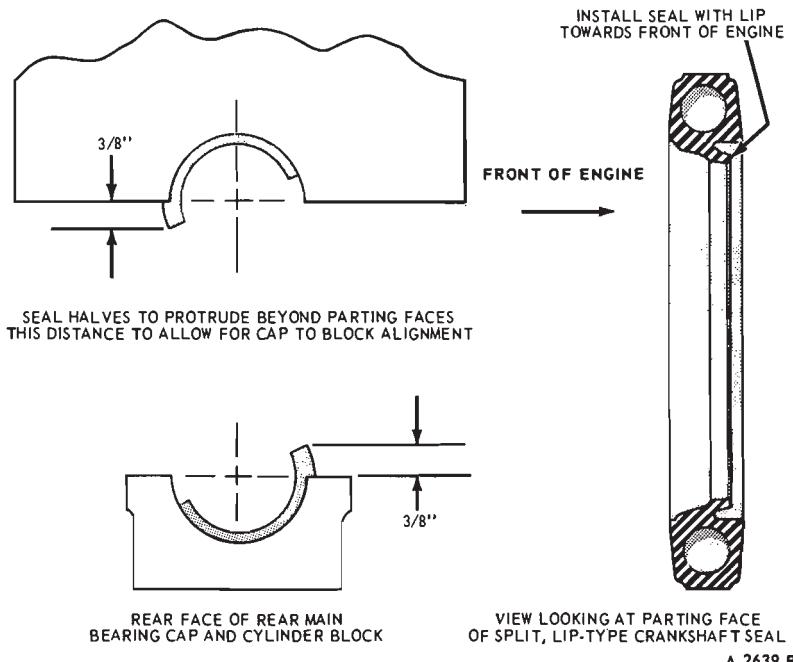
the gear expands enough to slip onto the flywheel. Make sure the gear is seated properly against the shoulder. **Do not heat any portion of the gear to a temperature higher than 500 degrees F. If this limit is exceeded, the temper will be removed from the ring gear teeth.**

#### CRANKSHAFT REAR OIL SEAL

A split-lip type crankshaft rear oil seal is provided for servicing all 1970 engines. The complete seal is replaced without removing the crankshaft.

#### Removal

1. Remove the oil pan and the oil pump (if required).
2. Loosen all the main bearing cap



**FIG. 34—Installing Crankshaft Rear Oil Seal**

bolts, thereby lowering the crankshaft slightly but not to exceed 1/32 inch.

3. Remove the rear main bearing cap, and remove the oil seal from the bearing cap and cylinder block. On the block half of the seal use a seal

removal tool, or install a small metal screw in one end of the seal, and pull on the screw to remove the seal. **Exercise caution to prevent scratching or damaging the crankshaft seal surfaces.**

- Remove the oil seal retaining pin from the bearing cap if so equipped. The pin is not used with the split-lip seal.

#### Installation

- Carefully clean the seal grooves in the cap and block with a brush and solvent.

- Dip the split lip-type seal halves in clean engine oil.

- Carefully install the upper seal (cylinder block) into its groove with undercut side of seal toward the FRONT of the engine (Fig. 34), by rotating it on the seal journal of the crankshaft until approximately 3/8 inch protrudes below the parting surface.

**Be sure no rubber has been shaved from the outside diameter of the seal by the bottom edge of the groove.**

- Tighten the remaining bearing cap bolts and torque to specifications.

- Install the lower seal in the rear main bearing cap with undercut side of seal toward the FRONT of the engine (Fig. 34), allow the seal to protrude approximately 3/8-inch above the parting surface to mate with the upper seal when the cap is installed.

- Apply a thin coating of oil-resistant sealer to the rear main bearing cap at the rear of the top mating surface. **Do not apply sealer to the area forward of the side seal groove.** Install the rear main bearing cap. Torque the cap bolts to specifications.

- Install the oil pump and oil pan. Fill the crankcase with the proper amount and viscosity oil.

- Operate the engine and check for oil leaks.

### 3 CLEANING AND INSPECTION

The cleaning and inspection procedures in this section are for a complete engine overhaul; therefore, for partial engine overhaul or parts replacement, follow the pertinent cleaning or inspection procedure.

#### INTAKE MANIFOLD

##### CLEANING

Remove all gasket material from the machined surfaces of the manifold. Clean the manifold in a suitable

solvent, and dry it with compressed air.

##### INSPECTION

Inspect the manifold for cracks, damaged gasket surfaces, or other defects that would make it unfit for further service. Replace all studs that are stripped or otherwise damaged. **Remove all filings and foreign matter that may have entered the manifold as a result of repairs.**

Check the baffle plate on the und-

erside of the manifold if so equipped. The baffle should be securely fastened at all retaining points.

#### EXHAUST MANIFOLDS

##### CLEANING

Remove all gasket material from the manifolds.

On the right exhaust manifold of the V-8 engines, make sure the automatic choke air inlet and outlet holes are completely open and the cover

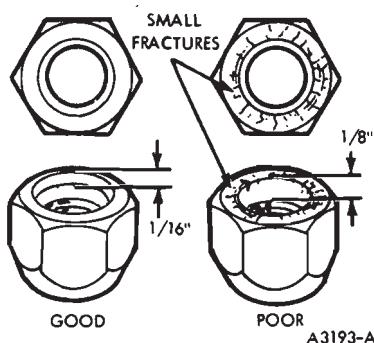


FIG. 35—Position Stop Rocker Arm Stud Nut

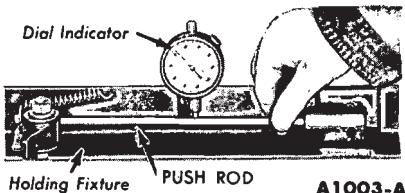


FIG. 36—Checking Push Rod Runout

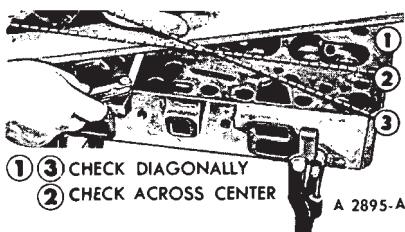


FIG. 37—Typical Cylinder Head Flatness

does not leak.

## INSPECTION

Inspect the cylinder head joining flanges of the exhaust manifold(s) for evidence of exhaust gas leaks.

Inspect the manifolds for cracks, damaged gasket surfaces, or other defects that would make them unfit for further service.

## VALVE ROCKER ARM AND/OR SHAFT ASSEMBLY

### CLEANING

Clean all the parts thoroughly. Make sure all oil passages are open.

Make sure the oil passage in the push rod end of the rocker arm is open.

### INSPECTION

On rocker arm shaft assemblies, check the clearance between each rocker arm and the shaft by checking

the ID of the rocker arm bore and the OD of the shaft. If the clearance between any rocker arm and the shaft exceeds the wear limit, replace the shaft and/or the rocker arm. Inspect the shaft and the rocker arm bore for nicks, scratches, scores or scuffs.

Inspect the pad at the valve end of the rocker arm for indications of scuffing or abnormal wear. If the pad is grooved, replace the rocker arm. **Do not attempt to true this surface by grinding.**

On stud-mounted rocker arms, check the rocker arm pad, side rails and fulcrum seat for excessive wear, cracks, nicks or burrs. Check the rocker arm stud and nut for stripped or broken threads. On positive stop rocker arm stud nuts, check the shoulder for damage as shown in Fig. 35. Replace all damaged nuts.

Check the adjusting nut(s) torque. If not within specifications replace the nut(s).

The cleaning and inspection procedures in this section are for a complete engine overhaul; therefore, for partial engine overhaul or parts replacement, follow the pertinent cleaning or inspection procedure.

## PUSH RODS

### CLEANING

Clean the push rods in a suitable solvent. Blow out the oil passage in the push rod with compressed air (all except 390 and 428 V-8).

### INSPECTION

Check the ends of the push rods for nicks, grooves, roughness or excessive wear.

The push rods can be visually checked for straightness while they are installed in the engine by rotating them with the valve closed. They also can be checked with a dial indicator (Fig. 36).

If the push rod is visibly bent, it should be checked with a dial indicator.

## CYLINDER HEADS

### CLEANING

On engines equipped with Thermactor exhaust emission control system, clean the cylinder head orifices with a wire brush. The main air passage on the 460 CID cylinder heads should be cleaned and inspected.

With the valves installed to protect

the valve seats, remove deposits from the combustion chambers and valve heads with a scraper and a wire brush. Be careful not to damage the cylinder head gasket surface. After the valves are removed, clean the valve guide bores with a valve guide cleaning tool. Use cleaning solvent to remove dirt, grease and other deposits. Clean all bolt holes; be sure the oil transfer passage is clean (390 and 428 V-8).

Remove all deposits from the valves with a fine wire brush or buffing wheel.

## INSPECTION

On 240 and 428 CID engines equipped with a Thermactor exhaust emission control system, inspect the air manifold connections for stripped or damaged threads and damaged tube nut seats. Inspect the cylinder heads for cracks or excessively burned areas in the exhaust outlet ports.

Check the cylinder head for cracks and inspect the gasket surface for burrs and nicks. Replace the head if it is cracked.

The following inspection procedures are for a cylinder head that is to be completely overhauled. For individual repair operations, use only the pertinent inspection procedure.

### Cylinder Head Flatness

When a cylinder head is removed because of gasket leaks, check the flatness of the cylinder head gasket surface (Fig. 37) for conformance to specifications. If necessary to refinish the cylinder head gasket surface, do not plane or grind off more than 0.010 inch.

### Valve Seat Runout

Check the valve seat runout with an accurate gauge (Fig. 38). Follow the instructions of the gauge manufacturer. If the runout exceeds the wear limit, reface the valve and valve seat.

### Valve Seat Width

Measure the valve seat width (Fig. 39). Reface the valve seats if the width is not within specifications.

### Valve Inspection

The critical inspection points and tolerances of the valves are illustrated in Fig. 39. Refer to the specifications for wear limits.

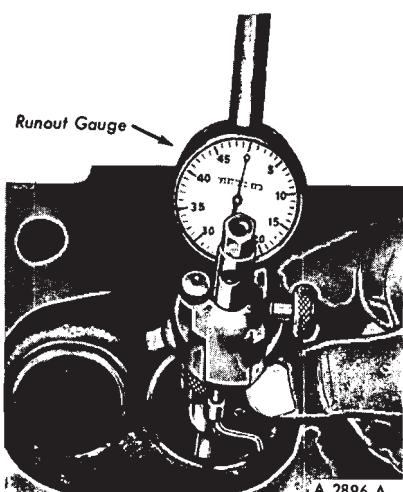


FIG. 38—Checking Valve Seat Runout

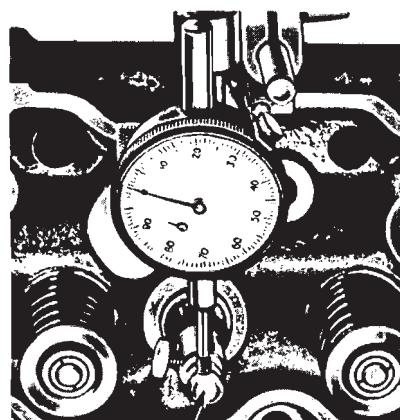


FIG. 40—Checking Valve Stem Clearance

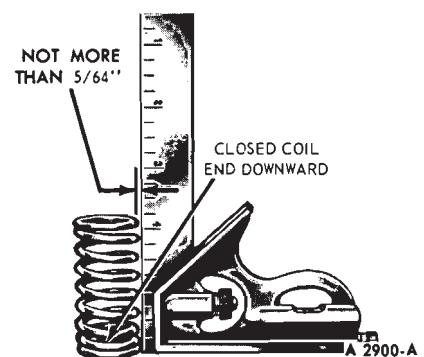


FIG. 42—Checking Valve Spring Squareness

be used to determine good and/or bad valve springs. Weak valve springs cause poor engine performance. Replace any spring not within specifications.

#### Valve Spring Squareness

Check each spring for squareness, using a steel square and a flat surface (Fig. 42). Stand the spring and square on end on the flat surface. Slide the spring up to the square. Revolve the spring slowly and observe the space between the top coil of the spring and the square. The out-of-square limits are  $5/64$ -inch.

Follow the same procedure to check new valve springs before installation.

Make certain the proper spring (Color coded) is installed.

Visually inspect the valve spring retainer to determine if the damper spring coil has been hitting the retainer. This interference will also cause a clicking noise when the engine is operating. The damper spring is properly installed in the valve spring when positioned so that the end of the damper spring bottom coil is 135 degrees counterclockwise from the end of the valve spring lower coil.

#### HYDRAULIC VALVE LIFTERS

The valve lifter assemblies should be kept in proper sequence so that they can be installed in their original position. Inspect and test each lifter separately so as not to intermix the internal parts. If any part of the lifter assembly needs replacing, replace the entire assembly.

#### CLEANING

Thoroughly clean all the parts in clean solvent and wipe them with a clean, lint-free cloth.

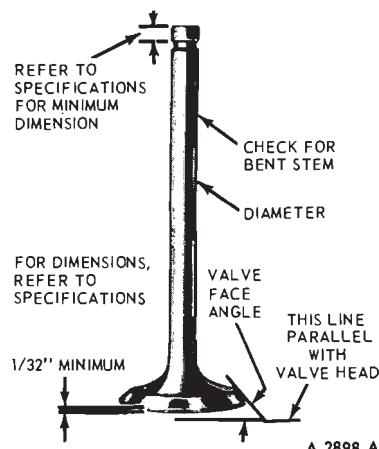


FIG. 39—Critical Valve Dimensions

Inspect the valve face and the edge of the valve head for pits, grooves, scores or other damage. Inspect the stem for a bent condition and the end of the valve head for pits, grooves, scores or other wear. Inspect the stem for a bent condition and the end of the stem for grooves or scores. Check the valve head for signs of burning, erosion, warpage and cracking. Minor pits, grooves etc., may be removed. Discard valves that are severely damaged.

Inspect the valve spring, valve spring retainers, locks and sleeves for wear or damage. Discard any visually damaged parts.

#### Valve Stem Clearance

Check the valve stem to valve guide clearance of each valve in its respective valve guide with the tool shown in Fig. 40 or its equivalent. Use a flat-

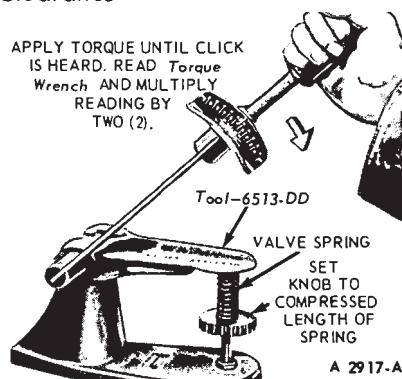


FIG. 41—Checking Valve Spring Pressure

end indicator point.

Install the tool on the valve stem until it is fully seated, and tighten the knurled set screw firmly. Permit the valve to drop away from its seat until the tool contacts the upper surface of the valve guide.

Position the dial indicator with its flat tip against the center portion of the tool's spherical section at approximately 90 degrees to the valve stem axis. Move the tool back and forth in line with the indicator stem. Take a reading on the dial indicator without removing the tool from the valve guide upper surface. Divide the reading by two, the division factor for the tool.

#### Valve Spring Pressure

Check the springs for proper pressure (Fig. 41) at the specified spring lengths. (Tool-6513-DD). Manually rotating the valve spring assemblies while installed in the engine, must not

**INSPECTION**

Inspect the parts and discard the entire lifter assembly if any part shows pitting, scoring, galling, excessive wear or evidence of non-rotation. Replace the entire assembly if the plunger is not free in the body. The plunger should drop to the bottom of the body by its own weight when assembled dry.

Assemble the lifter assembly and check for freeness of operation by pressing down on the push rod cup. The lifters can also be checked with a hydraulic tester to test the leakdown rate. Follow the instructions of the test unit manufacturer or the procedure in Section I.

**SOLID TAPPETS****CLEANING**

Thoroughly clean the tappets in clean solvent and wipe them with a clean lint-free cloth.

**INSPECTION**

Check the tappets for wear or scores. Check the bottom end of tappet to make sure that it has a slight convex. Replace tappets that are scored, worn or if the bottom is not smooth. If the bottom surface is worn flat, it may be used with the original camshaft only.

**TIMING CHAIN AND SPROCKETS****CLEANING**

Clean all parts in solvent and dry them with compressed air.

Lubricate the timing chain with engine oil before installing it on the engine.

**INSPECTION**

Inspect the chain for broken links. Inspect the sprockets for cracks and worn or damaged teeth. Replace all the components of the timing chain and sprocket assembly, if any one item needs replacement.

**TIMING GEARS****CLEANING**

Clean the gears in solvent, and dry them with compressed air.

**INSPECTION**

Inspect the gear teeth for scores, nicks, etc. Note the condition of the teeth contact pattern. If the teeth are scored, replace the gears.

On a 240 Six engine, it is not necessary to replace the gears in sets. Replace the camshaft gear and check the backlash, runout, etc., to determine if the crankshaft gear should be replaced.

**FUEL PUMP ECCENTRIC****CLEANING**

Clean the fuel pump eccentric in solvent and dry with compressed air.

**INSPECTION**

Inspect the fuel pump drive eccentric for scores, nicks and excessive wear. If the eccentric is scored, replace it.

**CAMSHAFT****CLEANING AND INSPECTION**

Clean the camshaft in solvent and wipe it dry. Inspect the camshaft lobes for scoring and signs of abnormal wear. Lobe wear characteristics may result in pitting in the general area of the lobe toe. This pitting is not detrimental to the operation of the camshaft; therefore, the camshaft should not be replaced until the lobe lift loss has exceeded 0.005 inch.

The lift of the camshaft lobes can be checked with the camshaft installed in the engine or on centers. Refer to Camshaft Lobe Lift.

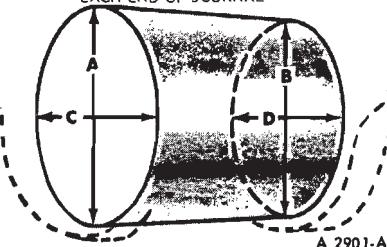
Check the distributor drive gear for broken or chipped teeth. Replace the camshaft if this condition exists.

**CRANKSHAFT VIBRATION DAMPER AND SLEEVE****CLEANING**

Clean the oil seal contact surface on the crankshaft damper or sleeve with solvent to remove any corrosion, sludge or varnish deposits. Excess deposits that are not readily removed with solvent may be removed with crocus cloth. Use crocus cloth to remove any sharp edges or burrs which might damage the oil seal during installation or cause premature seal wear. Do not use crocus cloth to the extent that the seal surface becomes polished. A finely polished surface may produce poor sealing or cause premature seal wear.

A VS B = VERTICAL TAPER  
C VS D = HORIZONTAL TAPER  
A VS C AND B VS D = OUT-OF-ROUND

CHECK FOR OUT-OF-ROUND AT EACH END OF JOURNAL



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**FIG. 43—Crankshaft Journal Measurement**

polished. A finely polished surface may produce poor sealing or cause premature seal wear.

**INSPECTION**

Inspect the crankshaft damper or sleeve oil seal surface for nicks, sharp edges or burrs that might damage the oil seal during installation or cause premature seal wear.

**CRANKSHAFT****CLEANING**

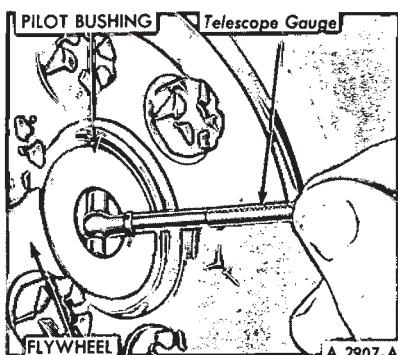
Handle the crankshaft with care to avoid possible fractures or damage to the finished surfaces. Clean the crankshaft with solvent, then blow out all oil passages with compressed air.

On a 240 Six engine, clean the oil seal contact surface at the rear of the crankshaft with solvent to remove any corrosion, sludge or varnish deposits. Excess deposits that are not readily removed with solvent may be removed with crocus cloth. Use crocus cloth to remove any sharp edges, or burrs which might damage the oil seal during installation or cause premature seal wear. Do not use crocus cloth to the extent that the seal surface becomes polished. A finely polished surface may produce poor sealing or cause premature seal wear.

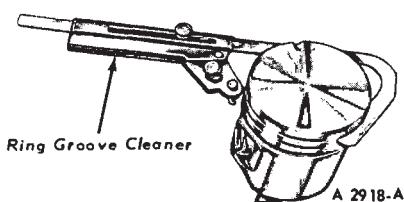
**INSPECTION**

Inspect the main and connecting rod journals for cracks, scratches, grooves or scores. Inspect the crankshaft oil seal surface for nicks, sharp edges or burrs that might damage the oil seal during installation or cause premature seal wear.

Measure the diameter of each journal in at least four places to determine an out-of-round, taper or und-



**FIG. 44—Checking Clutch Pilot Bushing Wear**



**FIG. 45—Cleaning Piston Ring Grooves—Typical**

ersize condition (Fig. 43).

On engines used with a Manual-Shift transmission, check the fit of the clutch pilot bushing in the bore of the crankshaft. The bushing is pressed into the crankshaft and should not be loose. Inspect the inner surface of the bushing for wear or a bell-mouth condition. Check the ID of the bushing (Fig. 44). Replace the bushing if it is worn or damaged or the ID is not within specifications.

Inspect the pilot bearing (ball bearing) when so equipped, for roughness, evidence of over heating or loss of lubricant. Replace it if any of these conditions are found.

#### **FLYWHEEL—MANUAL SHIFT TRANSMISSION**

##### **INSPECTION**

Inspect the flywheel for cracks, heat check, or other damage that would make it unfit for further service. Machine the friction surface of the flywheel if it is scored or worn. If it is necessary to remove more than 0.045 inch of stock from the original thickness, replace the flywheel.

Inspect the ring gear for worn, chipped, or cracked teeth. If the teeth are damaged, replace the ring gear.

With the flywheel installed on the crankshaft, check the flywheel face runout, following the procedure in Section 1.

#### **FLYWHEEL—AUTOMATIC TRANSMISSION**

##### **INSPECTION**

Inspect the flywheel for cracks or other defects that would make it unfit for further service. Inspect the flywheel ring gear for worn, chipped or cracked teeth. If the teeth are damaged, replace the ring gear and flywheel assembly.

With the flywheel installed on the crankshaft, check the gear face runout (refer to Section 1 for the proper procedure).

#### **CONNECTING RODS**

##### **CLEANING**

Remove the bearings from the rod and cap. Identify the bearings if they are to be used again. Clean the connecting rod in solvent, including the rod bore and the back of the inserts. **Do not use a caustic cleaning solution.** Blow out all passages with compressed air.

##### **INSPECTION**

The connecting rods and related parts should be carefully inspected and checked for conformance to specifications. Various forms of engine wear caused by these parts can be readily identified.

A shiny surface on either pin boss side of the piston usually indicates that a connecting rod is bent.

Abnormal connecting rod bearing wear can be caused by either a bent connecting rod, worn or damaged crankpin, or a tapered connecting rod bore.

Twisted connecting rods will not create an easily identifiable wear pattern, but badly twisted rods will disturb the action of the entire piston, rings and connecting rod assembly and may be the cause of excessive oil consumption.

Inspect the connecting rods for signs of fractures and the bearing bores for out-of-round and taper. If the bore exceeds the recommended limits and/or if the connecting rod is fractured, it should be replaced.

Check the piston pin to connecting rod bushing clearance. Replace the connecting rod if the bushing is so worn that it cannot be reamed or honed for an oversize pin (390 and 428 V-8 only).

On all engines except the 390 and

428, check the ID of the connecting rod piston pin bore. If the pin bore in the connecting rod is larger than specifications, install a 0.001 inch oversize piston pin. First, prefit the oversize piston pin to the piston pin bore by reaming or honing the piston to provide 0.0002—0.0004 inch clearance (light slip fit). Then, assemble the piston, piston pin and connecting rod following the procedures in Parts 21-02 through 21-06 and 21-08 through 21-09. **It is not necessary to ream or hone the pin bore in the connecting rod.**

Replace defective connecting rod nuts and bolts.

Check the connecting rods for bend or twist on a suitable alignment fixture. Follow the instructions of the fixture manufacturer. If the bend and/or twist exceeds specifications, the connecting rod must be straightened or replaced.

#### **PISTONS, PINS AND RINGS**

##### **CLEANING**

Remove deposits from the piston surfaces. Clean gum or varnish from the piston skirt, piston pins and rings with solvent. **Do not use a caustic cleaning solution or a wire brush to clean pistons.** Clean the ring grooves with a ring groove cleaner (Fig. 45). Make sure the oil ring slots (or holes) are clean.

##### **INSPECTION**

Carefully inspect the pistons for fractures at the ring lands, skirts and pin bosses, and for scuffed, rough or scored skirts. If the lower inner portion of the ring grooves has a high step, replace the piston. The step will interfere with ring operation and cause excessive ring side clearance.

Spongy, eroded areas near the edge of the top of the piston are usually caused by detonation or pre-ignition. A shiny surface on the thrust surface of the piston, offset from the centerline between the piston pin holes, can be caused by a bent connecting rod. Replace pistons that show signs of excessive wear, wavy ring lands or fractures or damage from detonation or pre-ignition.

Check the piston to cylinder bore clearance by measuring the piston and bore diameters. Refer to the specifications for the proper clearance. Refer to Cylinder Block Inspection for the bore measurement procedure. **Measure the OD of the piston with**

micrometers at the centerline of the piston pin bore and at 90 degrees to the pin bore axis. Check the ring side clearance following the procedure under Fitting Piston Rings in this section.

Replace piston pins showing signs of fracture, etching or wear. Check the piston pin fit in the piston and rod. Refer to Piston and Connecting Rod Assembly, in the pertinent engine section.

Check the OD of the piston pin and the ID of the pin bore in the piston. Replace any piston pin or piston that is not within specifications.

Replace all rings that are scored, broken chipped or cracked. Check the end gap and side clearance. Rings should not be transferred from one piston to another regardless of mileage.

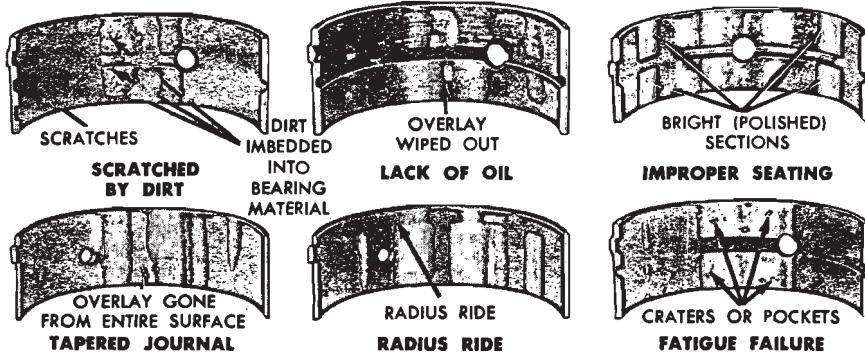
## MAIN AND CONNECTING ROD BEARINGS

### CLEANING

Clean the bearing inserts and caps thoroughly in solvent, and dry them with compressed air. Do not scrape gum or varnish deposits from the bearing shells.

### INSPECTION

Inspect each bearing carefully. Bearings that have a scored, chipped, or worn surface should be replaced. Typical examples of unsatisfactory bearings and their causes are shown in Fig. 46. The copper lead bearing base may be visible through the bearing overlay. This does not mean that the bearing is worn. It is not necessary to replace the bearing if the



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FIG. 46—Typical Bearing Failures

bearing clearance is within recommended limits. Check the clearance of bearings that appear to be satisfactory with Plastigage as detailed under Main and Connecting Rod Bearings.

## CYLINDER BLOCK

### CLEANING

After any cylinder bore repair operation, such as honing or deglazing, clean the bore(s) with soap or detergent and water. Then, thoroughly rinse the bore(s) with clean water to remove the soap or detergent, and wipe the bore(s) dry with a clean, lint-free cloth. Finally wipe the bore(s) with a clean cloth dipped in engine oil. If these procedures are not followed rusting of the cylinder bore(s) may occur.

If the engine is disassembled, thoroughly clean the block with solvent. Remove old gasket material from all machined surfaces. Remove all pipe plugs that seal oil passages; then clean out all the passages. Blow out all passages, bolt holes, etc., with compressed air.

On the 390 and 428 V-8, be sure the jiggle pin in the main oil gallery front plug operates freely.

Make sure the threads in the cylinder head bolt holes are clean. Dirt in the threads may cause binding and result in a false torque reading. Use a tap to true-up threads and to remove any deposits.

Thoroughly clean the grooves in the crankshaft bearings and bearing retainers.

### INSPECTION

After the block has been thorough-

ly cleaned, check it for cracks. Minute cracks not visible to the naked eye may be detected by coating the suspected area with a mixture of 25% kerosene and 75% light engine oil. Wipe the part dry and immediately apply a coating of zinc oxide dissolved in wood alcohol. If cracks are present, the coating will become discolored at the defective area. Replace the block if it is cracked.

Check all machined gasket surfaces for burrs, nicks, scratches and scores. Remove minor imperfections with an oil stone. Check the cylinder block for flatness of the cylinder head gasket surface following the procedure and specifications recommended for the cylinder head. The cylinder block can be machined to bring the cylinder head gasket surface within the flatness specifications, but not to exceed 0.010 inch original stock removal.

Replace all expansion-type plugs that show evidence of leakage.

Inspect the cylinder walls for scoring, roughness, or other signs of wear. Check the cylinder bore for out-of-round and taper. Measure the bore with an accurate bore gauge following the instructions of the manufacturer. Measure the diameter of each cylinder bore at the top, middle and bottom with the gauge placed at right angles and parallel to the centerline of the engine (Fig. 47). Use only the measurements obtained at 90 degrees to the engine centerline when calculating the piston to cylinder bore clearance.

Refinish cylinders that are deeply scored and/or when out-of-round and/or taper exceed the wear limits.

If the cylinder walls have minor

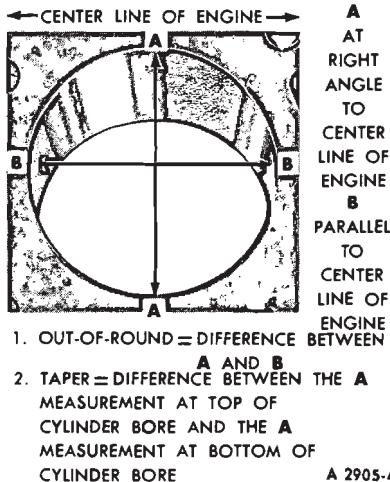


FIG. 47—Cylinder Bore Out-of-Round and Taper

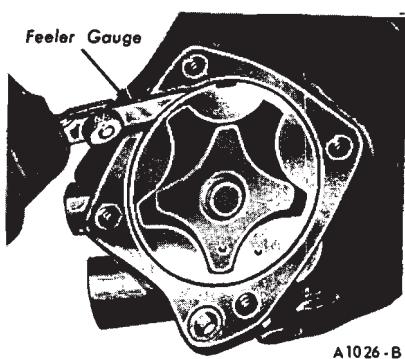


FIG. 48—Checking Outer Race to Housing Clearance

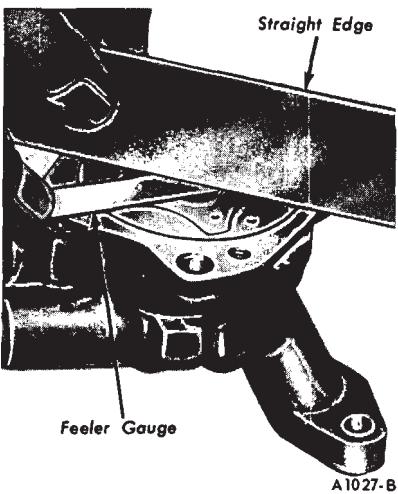


FIG. 49—Checking Rotor End Play

surface imperfections, but the out-of-round and taper are within limits, it may be possible to remove the imperfections by honing the cylinder walls and installing new service piston rings providing the piston clearance is within specified limits. Refer to Section 2.

## OIL PAN

### CLEANING

Scrape any dirt or metal particles from the inside of the pan. Scrape all old gasket material from the gasket surface. Wash the pan in a solvent

and dry it thoroughly. Be sure all foreign particles are removed from below the baffle plate.

### INSPECTION

Check the pan for cracks, holes, damaged drain plug threads, and a loose baffle or a damaged gasket surface.

Inspect for damage (uneven surface) at the bolt holes caused by over torquing the bolts. Straighten surfaces as required. Repair any damage, or replace the pan if repairs cannot be made satisfactorily.

## OIL PUMP

### CLEANING

Wash all parts in a solvent and dry them thoroughly with compressed air. Use a brush to clean the inside of the pump housing and the pressure relief valve chamber. Be sure all dirt and metal particles are removed.

### INSPECTION

Refer to the specifications for clearances and wear limits.

Check the inside of the pump housing and the outer race and rotor for damage or excessive wear.

Check the mating surface of the pump cover for wear. If the cover mating surface is worn, scored or grooved, replace the cover.

Measure the outer race to housing clearance (Fig. 48).

With the rotor assembly installed in the housing, place a straight edge over the rotor assembly and the housing. Measure the clearance (rotor end play) between the straight edge and the rotor and outer race (Fig. 49).

**The outer race, shaft and rotor are replaceable only as an assembly.**

Check the drive shaft to housing bearing clearance by measuring the OD of the shaft and the ID of the housing bearing.

Inspect the relief valve spring for a collapsed or worn condition. Check the relief valve spring tension. If the spring tension is not within specifications and/or the spring is worn or damaged replace the spring.

Check the relief valve piston for scores and free operation in the bore.

## POSITIVE CLOSED-TYPE CRANKCASE VENTILATION SYSTEM

Refer to the 1970 Passenger Car Maintenance and Lubrication Manual, Volume Five for the correct mileage interval for maintenance.

### CLEANING

**Do not attempt to clean the crankcase ventilation regulator valve, it should be replaced at the specified maintenance interval.**

The oil filler cap and oil separator (in right valve cover if so equipped) should be cleaned at the proper mileage interval. Remove the cap and the oil separator and wash them in a low-volatility, petroleum base solvent. Shake the cap dry and install them. **Do not dry with compressed air as air pressure may damage the filter element.**

Clean the crankcase ventilation system connection(s) on the carburetor spacer or intake manifold by probing with a flexible wire or bottle brush.

Clean the hoses, fittings, tubes and associated hardware with a low-volatility, petroleum-base solvent and dry with compressed air.

## THERMATOR EXHAUST EMISSION CONTROL SYSTEM

### AIR BYPASS VALVE

**Do not attempt to clean the air bypass valve.**

### HOSES, LINES AND AIR MANIFOLDS

Clean, inspect and replace the hoses at the specified interval. Refer to the Maintenance Schedule. Use a low-volatility, petroleum-base solvent and a suitable stiff bristle brush to clean the component parts. Dry the cleaned parts, except the check valve, with compressed air. **Do not blow compressed air through the check valve in either direction. Shake it dry.**

### AIR SUPPLY PUMP

The air supply pump is not repairable and must be replaced as an assembly.

## SPECIAL TOOLS

Description	Ford Tool No.	Former No.	Application Engine Size					
			170-200 250 Six	240 Six	302-351-W V-8	351-C V-8	390-428 V-8	429-460 V-8
Valve Stem Seal Removing and Installing Tool	Tool VSIT-1							②
Crankshaft Front Seal Installing Tool	T70P-6B070-A					X		
Crankshaft Front Seal Removing Tool	T70P-6B070-B					X		
Impact Hammer	T50T-100-A		X	X	X	X	X	X
Puller Attachment Use with T50T-100-A or T59L-100-B	T58L-101-A		X	X	X	X	X	X
Handle Adapter	T53L-200-A		X	X	X	X	X	X
Engine Lifting Sling	T53L-300-A	6000-BA	X	X	X	X	X	X
Water By-Pass Orifice Plug Installing Tool	T70P-6K517-A					X		
Differential Backlash and Runout Gauge, with Universal Bracket and Dial Indicator (1-1/4 inch range). Includes Indicator TOOL-6565	TOOL-4201-C	4201-C	X	X	X	X	X	X
Engine Lifting Bracket—Use with T53L-300-A	T58P-6000-A	6000-BD					X	
Engine Lifting Hook	T65L-6000-A			X				X
Adapter Mount To Fit K.R. Wilson 1009 or Manzel 6001-TES	T64L-6001-B			X	X	X	X	X
Cam Bearing Bore Plug Installing Tool	T70P-6011-A					X		
Cylinder Front Cover Pilot	T61P-6019-B	6059-F	X	X	X		X	
Cylinder Front Cover Pilot	T68P-6019-A							X
Valve Spring Compressor, on Engine	T70P-6049-A					X		
Rocker Arm Stud Driver	T69P-6049-D				X			
Valve Guide Reamer Kit	T52L-6085-AEE			X	X	X		X
Valve Guide Reamer Kit	T58P-6085-B						X	
Valve Guide Reamer Kit	T60K-6085-B		X					
Engine Lifting and Head Holding Brackets	T62F-6085-A	6005-BDA			X			
Piston Pin Remover	T52P-6135-DAD						X	
Piston Pin Remover and Replacer Press	T65L-6135-C	6135-J		X				
Piston Pin Remover and Replacer Press	T68P-6135-A				X	X		X
Camshaft Bearings Remover and Replacer Adapters	T65L-6250-A	T52L-6261-CEE	X	X	X	X	X	X
Camshaft Bearing Bore Plug Replacer-Adapter Use with T53L-208-A	T58P-6266-A						X	
Camshaft Rear Bearing Bore Plug Replacer-Adapter Use with T53L-200-A	T62F-6266-A				X			X
Crankshaft Damper Replacer	T64T-6306-A		X	X	X	X	X	
Crankshaft Damper Replacer	T64T-6306-A			X				X
Crankshaft Damper Remover	T58P-6316-B			X			X	X
Crankshaft Damper Remover Adapter Screw	T64T-6316-A			X				X

① 200 Six Only

② 429 Boss Only

## SPECIAL TOOLS (continued)

Description	Ford Tool No.	Former No.	Application Engine Size					
			170-200 250 Six	240 Six	302-351-W V-8	351-C V-8	390-428 V-8	429-460 V-8
Upper Main Bearing Insert Remover and Replacer	TOOL-6331	6331		X	X	X		
Upper Main Bearing Remover and Replacer	TOOL-6331-E	6331-E					X	X
Hydraulic Tappet Clip Replacer	TOOL-6500-C	6500-C	X	X	X	X	X	X
Hydraulic Tappet Leakdown Tester	TOOL-6500-E	6500-E	X	X	X	X	X	X
Hydraulic Tappet Plunger Remover and Replacer	TOOL-6500-F	6500-F	X	X	X	X	X	X
Valve Stem Deburring Tool	T70P-6505-A					X		
Valve Stem Clearance Checking Tool	TOOL-6505-E	6505-E		X	X	X		X
Valve Stem Clearance Checking Tool	TOOL-6505-F			X				
	TOOL-6505-G	6505-G	X					
Valve Spring Compressor	T65P-6513-A		X					
Air Adapter and Hose-Valve Holdup	TOOL-6513-ABA	6513-AB	X	X	X		X	X
Compressor-Tappet Bleed Down	T58P-6565-A						X	
	TOOL-6513-AC	6513-AC		X	X			X
Valve and Clutch Spring Tester	TOOL-6513-DD	6513-DD	X	X	X	X	X	X
Valve Spring and Rocker Arm Compressor	TOOL-6513-J	6513-J					X	
Push Rod Check Compressor	TOOL-6513-K	6513-K	X					
Rocker Arm Stud Kit	T62F-6A527-B		X	X	X			X
Rocker Arm Stud Installer (Supplements T62F-6A527-B)	T65P-6A527-A			X				
Hydraulic Tappet Bleed-Down Tool	T70P-6564-A					X		
Cam Lift and Push Rod Stroke Dial Indicator (1-inch range) Use with Bracket from TOOL-4201-C	TOOL-6565	6565	X	X	X	X	X	X
Cup Shaped Adapter to TOOL-6565	TOOL-6565-AB	6565-AB	X	X	X	X	X	X
Valve Spring Compressor	T62F-6565-A	6513-HH		X	X			X
Crankcase Ventilation System Tester (Kit)	C8AZ-6B627-A		X	X	X	X	X	X
Cylinder Block Front Cover Oil Seal Replacer Adapter	T60K-6700-A	6700-C	X					
Cylinder Block Front Cover Oil Seal Replacer Adapter Use with T53L-200-A	T58P-6700-B	6700-B		X	X		X	
Front Cover Oil Seal Replacer	T68P-6700-A							X
Clutch Disc Pilot	T58P-7563-A				X	X		
Clutch Disc Alignment Pilot	TOOL-7563-E	7563-E	X					
Clutch Pilot Bearing Replacer	TOOL-7600-H	7600-H	X		X	X	X	
Clutch Pilot Bearing Replacer	T65L-7600-A			X				

① 429 Boss only

# PART 21-02 170,200 and 250 CID Six Engine

MODEL APPLICATION—170—MAVERICK 200—FALCON, MAVERICK AND MUSTANG 250—FAIRLANE, MONTEGO AND MUSTANG			
Component	Page	Component	Page
CAMSHAFT		MAIN AND CONNECTING ROD	
Bearing Bore Plug .....	02-11	BEARINGS	
Bearing Removal and Installation .....	02-19	Connecting Rod Bearings .....	02-12
Camshaft Removal and Installation .....	02-10	Main Bearings .....	02-12
CLUTCH PILOT BUSHING		OIL FILTER	
Installation .....	02-15	Installation .....	02-15
Removal .....	02-15	Removal .....	02-15
CRANKSHAFT		OIL PAN	
Installation .....	02-18	Installation .....	02-15
Removal .....	02-18	Removal .....	02-15
CYLINDER ASSEMBLY (SHORT BLOCK)		OIL PUMP	
Assembly .....	02-20	Assembly .....	02-16
Disassembly .....	02-20	Disassembly .....	02-16
CYLINDER BLOCK		Installation .....	02-16
Assembly .....	02-20	Removal .....	02-16
Disassembly .....	02-20	PISTONS AND CONNECTING RODS	
CYLINDER FRONT COVER AND TIMING CHAIN		Assembly .....	02-14
Installation .....	02-10	Disassembly .....	02-14
Oil Seal .....	02-10	Installation .....	02-13
Removal .....	02-09	Removal .....	02-13
CYLINDER HEAD		SPECIFICATIONS	02-23
Assembly .....	02-07	VALVE CLEARANCE ADJUSTMENT	02-05
Disassembly .....	02-07	VALVE LIFTERS	
Installation .....	02-06	Assembly .....	02-12
Removal .....	02-06	Disassembly .....	02-12
ENGINE		Installation .....	02-12
Assembly .....	02-20	Removal .....	02-12
Description .....	02-02	VALVE ROCKER ARM SHAFT	
Disassembly .....	02-20	Assembly .....	02-06
Removal and Installation .....	02-16	Disassembly .....	02-06
Supports—Front .....	02-02	Installation .....	02-06
Supports—Rear .....	02-04	Removal .....	02-06
EXHAUST EMISSION CONTROL SYSTEM		VENTILATION SYSTEM—CRANKCASE	
Description .....		Installation .....	02-05
EXHAUST MANIFOLD		Removal .....	02-05
Installation .....	02-05	WATER PUMP	
Removal .....	02-05	Installation .....	02-09
FLYWHEEL		Removal .....	02-09
Installation .....	02-15		
Removal .....	02-15		

## 1 DESCRIPTION

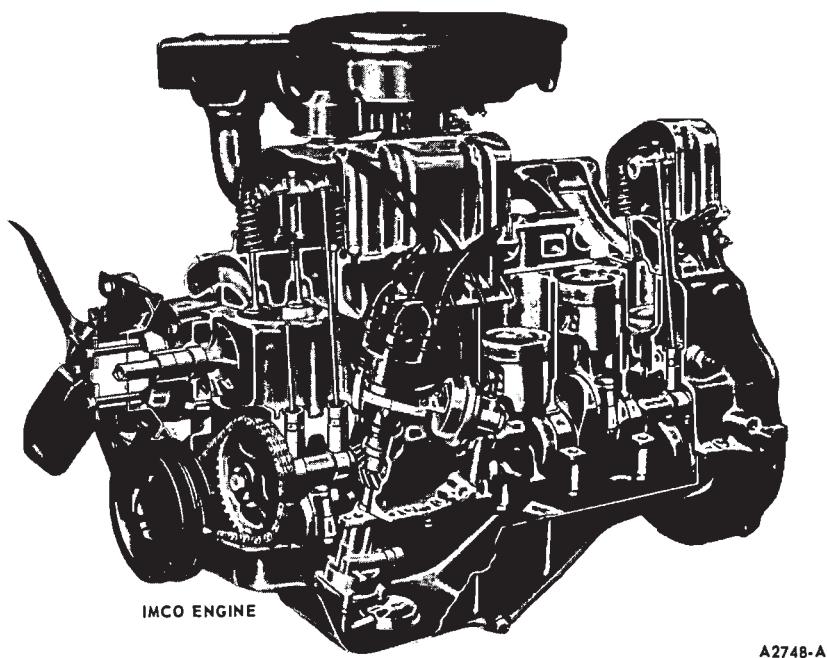


FIG. 1—Sectional View of Typical Six-Cylinder Engine

## 2 IN-VEHICLE ADJUSTMENTS AND REPAIRS

When installing nuts or bolts that must be torqued (refer to the end of this Part for torque specifications), oil the threads with light-weight engine oil. **Do not oil threads that require oil-resistant or water-resistant sealer.**

Refer to Part 21-01 for cleaning and inspection and engine test procedures.

### ENGINE FRONT SUPPORTS

The procedures given apply to either a right or left installation.

The engine front supports are located on each side of the cylinder block (Figs. 2 through 6).

#### MAVERICK 170-200 CID AND MUSTANG 200 CID ENGINE

##### Removal

1. Remove the insulator to support bracket nuts and washers from both insulators (Figs. 2 and 3).
2. Raise the engine with a jack and wood block placed under the oil pan.
3. Remove the insulator-to-engine bolts and washers and remove the insulator.

##### Installation

1. Position the insulator assembly on the engine and install the insula-

### ENGINE

The 170, 200 and 250 CID six-cylinder engines are in-line, overhead valve design of lightweight cast iron construction. The rating plate identification symbol for the 170 CID engine is U; for the 200 CID, it is T; and the symbol for the 250 CID is L.

Adjustment and repair procedures for the three engines are basically the same except the 200 and 250 CID engines have seven main bearings and the 170 CID engine has five.

A sectional view of a typical six-cylinder engine is shown in Fig. 1.

A positive closed-type crankcase ventilation system reduces the amount of air pollutants emitted by the crankcase ventilating system.

### EXHAUST EMISSION CONTROL SYSTEM

The 170, 200 and 250 CID engines incorporate an IMCO exhaust emission control system.

The IMCO exhaust emission control system is designed to reduce the hydrocarbon and carbon monoxide content of gasoline engine exhaust gases. By controlling the amount of contaminants emitted through the exhaust system to an acceptable minimum, air pollution is reduced. This is achieved by using a specially-calibrated carburetor and distributor.

tor-to-engine bolts and washers finger-tight.

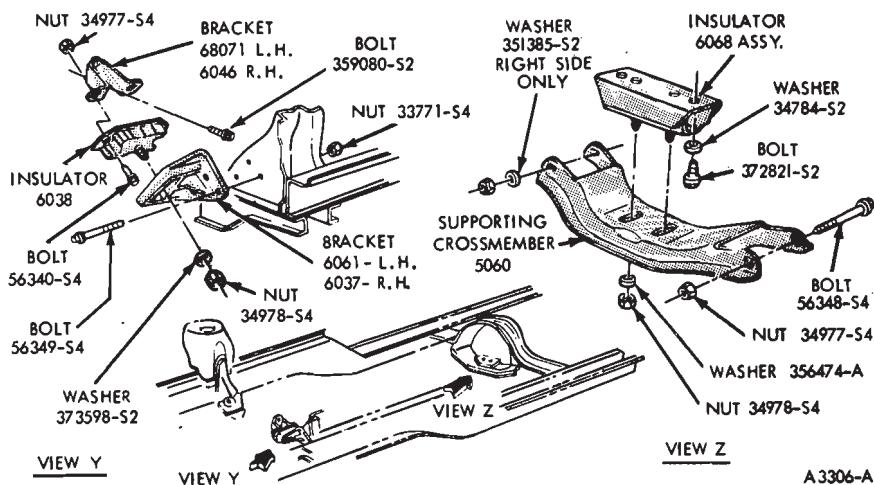
2. Lower the engine carefully to make sure the insulator stud engages the hole in the support bracket.

3. Install the insulator to support bracket washer and nut on both engine front mounts. Tighten the insulator bolts and nuts to specifications.

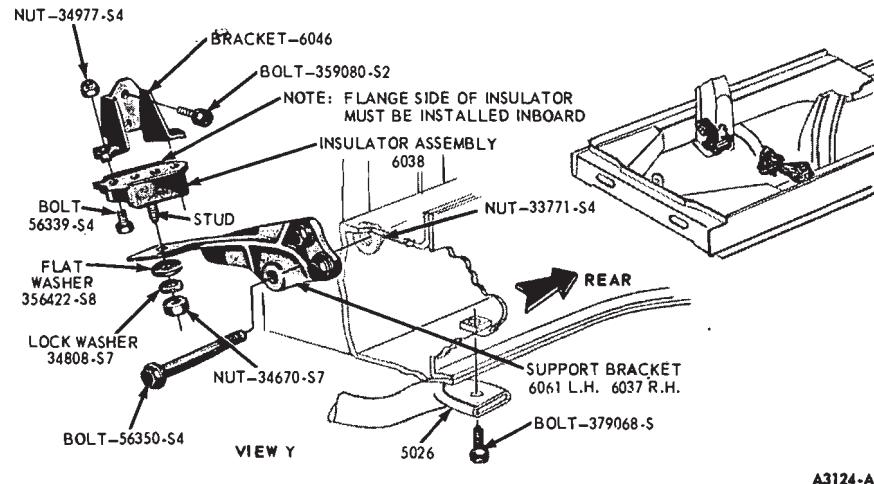
### MUSTANG, FAIRLANE, AND MONTEGO (250 CID ENGINE)

##### Removal

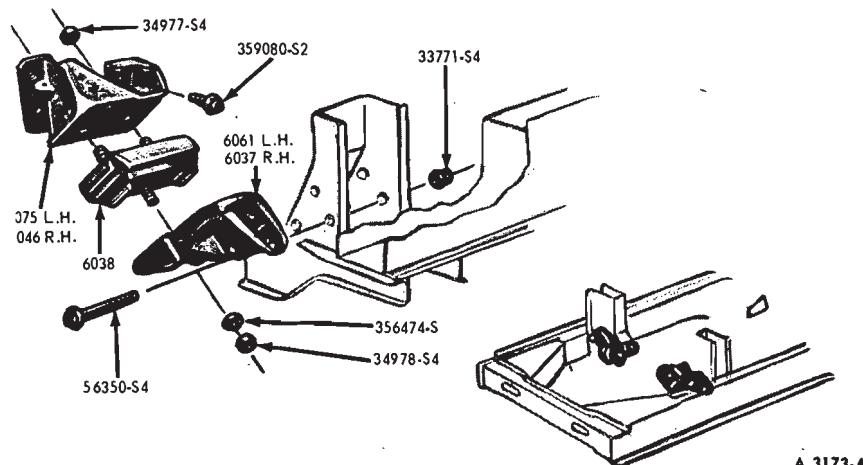
1. Remove the insulator bracket-to-block attaching screws (Mustang, (Fig. 4). For Fairlane, Fairlane Ran-



IG. 2—Maverick Engine Front and Rear Supports—170 and 200 CID engines



IG. 3—Mustang Engine Front Supports—200 CID Engine



IG. 4—Mustang Engine Front Supports—250 CID Engine

chero and Montego see Fig. 6.

2. Using a wood block placed under the oil pan, raise the engine just enough to remove the weight from the through bolt, and remove the through bolt (except Mustang). On Mustang, remove the insulator support attaching nut from beneath the frame bracket; then raise the engine enough for the stud to clear.

3. Slide the insulator and bracket from the block.

4. On the bench, remove the insulator-to-bracket attaching nuts, and remove the insulator.

### Installation

1. Position the new insulator on the bracket and install the attaching nuts and torque them to specifications.

2. Slide the insulator and bracket assembly into position at the cylinder block.

3. Install the through bolt (except Mustang).

4. Install the insulator bracket-to-block attaching screws and torque them to specifications. On a Mustang, gently lower the engine guiding the stud through the frame bracket.

5. Install the attaching nut and washer and torque to specifications.

6. Remove the jack and the wood block.

### FIARLANE, FALCON AND MONTEGO (EXCEPT 250 CID ENGINE)

#### Removal

1. Remove the insulator to lower support bracket attaching nut and washer (Fig. 5).

2. Using a wood block placed under the oil pan raise the engine approximately 1/2 inch.

3. Remove two bolts, each side, attaching upper insulator bracket to engine.

4. Remove insulator assembly and upper bracket. Remove nuts and bolts attaching insulator to upper bracket and separate parts.

#### Installation

1. Attach insulator assembly to upper bracket with bolts and nuts.

2. Install insulator assembly and upper bracket with two bolts, on each side to engine.

3. Carefully lower the engine guiding the insulator bolt into the lower support bracket.

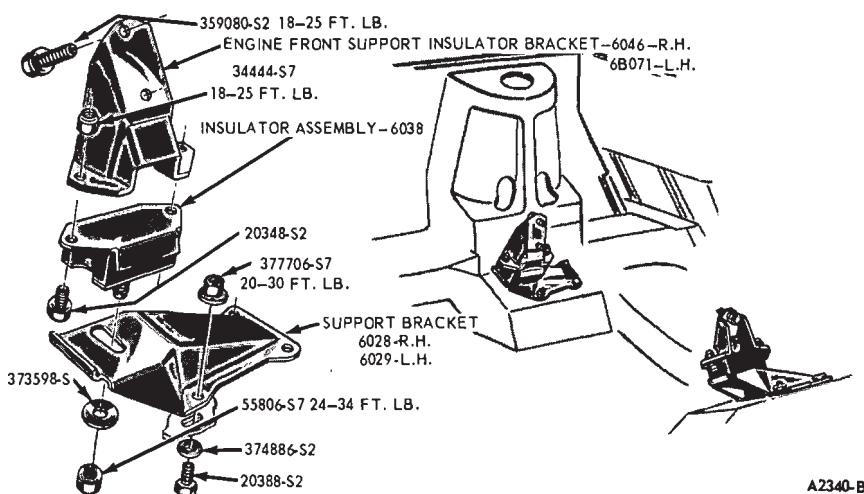


FIG. 5—Fairlane, Falcon and Montego Engine Front Supports (Except 250 CID Engine)

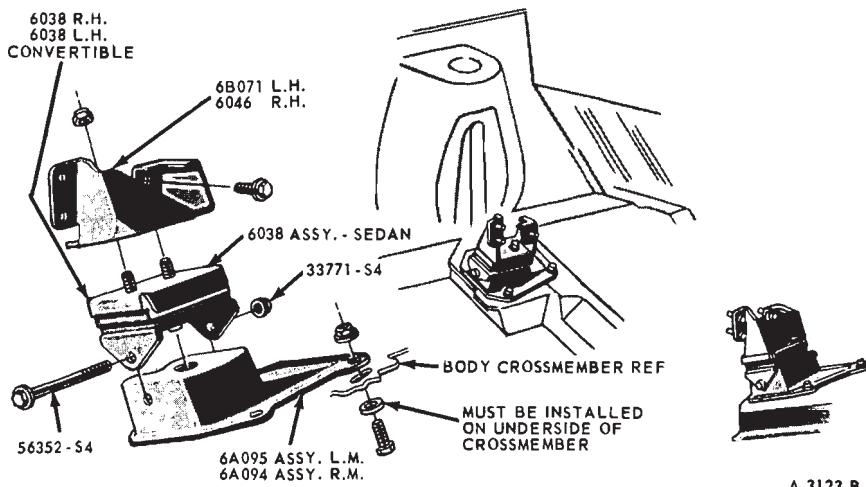


FIG. 6—Fairlane and Montego Engine Front Supports—250 CID Engine

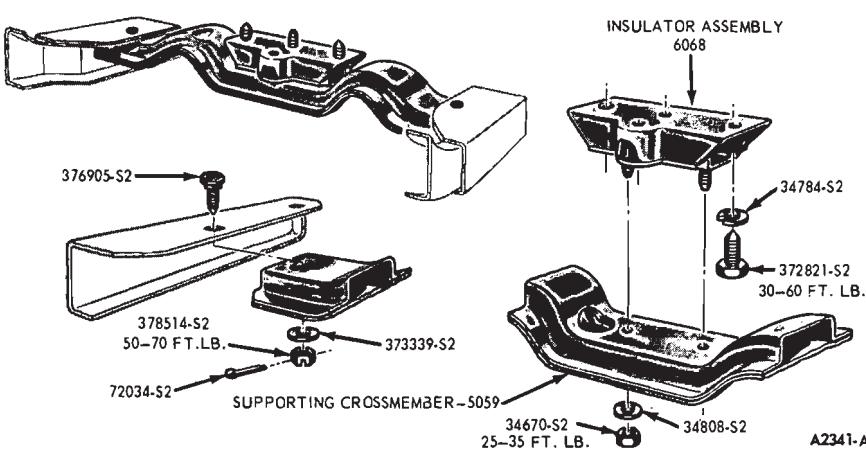


FIG. 7—Fairlane, Falcon and Montego Engine Rear Support

4. Install the insulator to lower support bracket attaching nut and washer, and torque to specifications.

### ENGINE REAR SUPPORT

The rear support is located at the transmission extension housing (Fig. 7).

#### FAIRLANE, FALCON AND MONTEGO

##### Removal

1. Support the transmission with a floor jack to remove weight from the supporting crossmember.

2. Remove nuts and washers attaching insulator assembly to crossmember.

3. Remove the attaching nuts, washers, and cotter keys from the supporting crossmember, and remove the supporting crossmember.

4. Remove the bolts and washers that attach the engine rear insulator assembly to the transmission.

5. Remove the insulator assembly.

##### Installation

1. Position the engine rear insulator assembly in place beneath the transmission, and install the attaching bolts and washers. Torque them to specifications.

2. Position the supporting crossmember and install the attaching washers and nuts. Torque them to specifications.

3. Install the cotter keys. If necessary, continue tightening the two outer nuts as required to align the castellations.

4. Install the nuts and washers attaching the insulator assembly to the crossmember. Tighten to specification.

5. Remove the jack.

#### MAVERICK AND MUSTANG

##### Removal

1. Remove the insulator to rear support nuts and washers (Figs. 2 and 8).

2. Raise and support the transmission with a transmission jack.

3. Loosen one of the rear support-to-crossmember bolts.

4. Remove the other rear support-to-crossmember bolt, washer (right side only) and nut, and swing the rear support down and out of the way.

5. Remove the insulator-

to-transmission bolts and washers and remove the insulator.

### Installation

- Position the insulator against the transmission and install the insulator-to-transmission bolts and washers. Torque the bolts to specifications.

- Swing the rear support up into position and install the rear support-to-crossmember bolt washer (right side only) and nut. Torque both rear support-to-crossmember nuts to specifications.

- Lower the transmission and install the insulator-to-rear support nuts

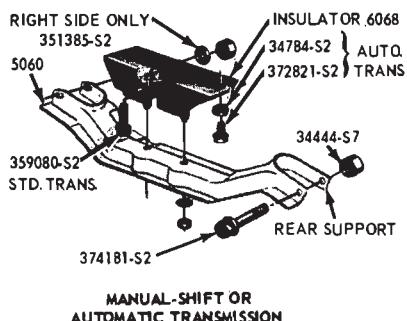


FIG. 8—Mustang Engine Rear Support

and washers. Torque the nuts to specifications.

### EXHAUST MANIFOLD

#### REMOVAL

- Remove the air cleaner and hot air duct. Disconnect the muffler inlet pipe from the exhaust manifold, and remove the automatic choke hot air tube.

- Bend the exhaust manifold attaching bolt lock tabs back and remove the bolts. Remove the exhaust manifold.

#### INSTALLATION

- Clean the mating surfaces of the exhaust manifold and cylinder head. Scrape the gasket material from the mounting flange of the exhaust manifold and muffler inlet pipe.

- Apply graphite grease to the mating surface of the exhaust manifold.

- Position the exhaust manifold on the cylinder head and install the attaching bolts and tab washers. Working from the center to the ends, torque the bolts to specifications. Lock the bolts by bending one tab of the washer over a flat on the bolt.

- Place a new gasket on the muffler inlet pipe. Position the muffler inlet pipe to the manifold. Install and torque the attaching nuts to specifications. Install the automatic choke hot air tube.

- Install the air cleaner and hot air duct. Start the engine and check for exhaust leaks.

### CRANKCASE VENTILATION SYSTEM

The closed crankcase ventilation system components are shown in Fig. 9.

#### REMOVAL

- Remove the inlet hose from the air cleaner and the oil filler cap.

- Remove the air cleaner.

- Grasp the crankcase vent hose near the rocker arm cover grommet and pull the regulator valve from the rocker arm cover.

- Remove the regulator valve from the vent hose and remove the vent hose from the hose fitting in the carburetor spacer.

#### INSTALLATION

- Install the vent hose on the fitting in the carburetor spacer and the regulator valve in the hose.

- Insert the regulator valve into the rocker arm cover mounting grommet.

- Install the air cleaner.

- Connect the inlet hose to the air cleaner and the oil filler cap.

- Operate the engine and check for leaks.

### VALVE CLEARANCE ADJUSTMENT

A 0.060-inch shorter than standard push rod and a 0.060-inch longer than standard push rod are available for service to provide a means of compensating for dimensional changes in the valve mechanism. Refer to the Master Parts List or the specifications for the pertinent color code.

Valve stem to valve rocker arm clearance should be within specifications with the hydraulic lifter completely collapsed. Repeated valve reconditioning operations (valve and/or valve seat refacing) will decrease the clearance to the point that, if not compensated for, the hydraulic valve lifter will cease to function and the valve will be held open.

To determine whether a shorter or a longer push rod is necessary, make

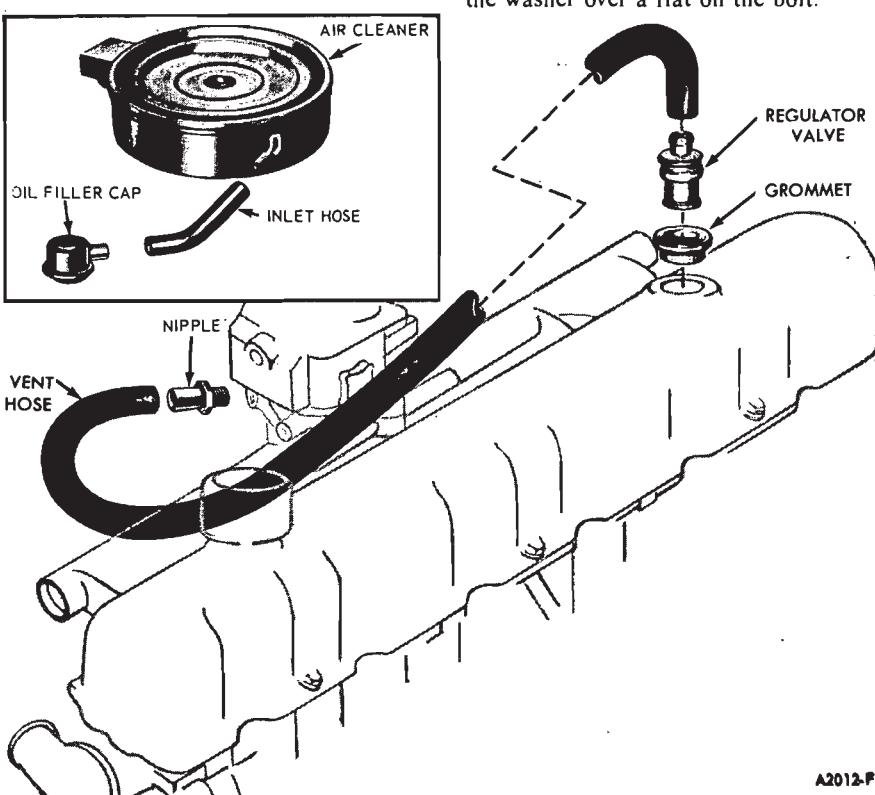


FIG. 9—Closed Crankcase Ventilation System Components

the following check:

1. Disconnect the brown lead (I terminal) and the red and blue lead (S terminal) at the starter relay. Install an auxiliary starter switch between the battery and S terminals of the Starter relay. Crank the engine with the ignitions switch OFF until the No. 1 piston is on TDC after the compression stroke.

2. With the crankshaft in the positions designated in Steps 3 and 4, position the hydraulic lifter compressor tool on the rocker arm. Slowly apply pressure to bleed down the hydraulic lifter until the plunger is completely bottomed (Fig. 10). Hold the lifter in this position and check the available clearance between the rocker arm and the valve stem tip with a feeler gauge.

If the clearance is less than specifications, install an under size push rod. If the clearance is greater than specifications, install an oversize push rod.

3. With the No. 1 piston on TDC after the compression stroke, use the procedure in step 2 and check the following valves:

- No. 1 Intake
- No. 1 Exhaust
- No. 2 Intake
- No. 3 Exhaust
- No. 4 Intake
- No. 5 Exhaust

4. Now rotate the crankshaft until the No. 6 piston is on TDC after the compression stroke (1 revolution of the crankshaft). By using the procedure in step 2, check the following valves:

- No. 2 Exhaust
- No. 3 Intake
- No. 4 Exhaust
- No. 5 Intake
- No. 6 Intake
- No. 6 Exhaust

5. When compressing the valve spring to remove the push rods, be sure the piston in the individual cylinder is below TDC to avoid contact between the valve and the piston.

To replace a push rod, it will be necessary to remove the valve rocker arm shaft assembly.

Upon replacement of a valve push rod, valve rocker arm shaft assembly or hydraulic valve lifter, the engine should not be cranked or rotated until the hydraulic lifters have had an opportunity to leak down to their normal operating position. The leak down rate can be accelerated by using the tool shown in Fig. 10 on the valve rocker arm and applying pressure in a direction to collapse the lifter.

## VALVE ROCKER ARM SHAFT ASSEMBLY

### REMOVAL

1. Remove the air cleaner and the crankcase ventilation system.
2. Remove the valve rocker arm cover and discard the gasket.
3. Remove the rocker arm shaft support bolts by loosening the bolts two turns at a time in sequence. Remove the rocker arm shaft assembly (Fig. 11). Remove the valve push rods. Make sure the push rods are identified before removal so they can be returned to the same location when they are installed.

### INSTALLATION

1. Apply Lubriplate to both ends of the push rods and to the valve stem tip.
2. Install the valve push rods. Position the valve rocker arm shaft assembly on the cylinder head.
3. Install and tighten all valve rocker arm support bolts, two turns at a time in sequence, until the supports fully contact the cylinder head. Torque the bolts to specifications.

4. If any part which could affect the valve clearance has been changed, check the valve clearance following the procedure outlined under Hydraulic Valve Lifter—Rocker Shaft Mounted Rocker Arms (Part 21-01, Engine Tests).

5. Clean the valve rocker arm cover and cylinder head gasket surfaces. Coat one side of a new gasket with an oil resistant sealer and lay the cemented side of the gasket in place on the cover. Install the cover, making sure the gasket seats evenly around the head. Tighten the cover attaching bolts in two steps. First, torque the bolts to specifications; then, retorque to the same specifications two minutes after initial tightening.

6. Install the crankcase ventilation system and the air cleaner.

### DISASSEMBLY

1. Remove the pin and spring washer from each end of the valve rocker arm shaft.
2. Slide the valve rocker arms, springs, and supports off the shaft. Be sure to identify the parts.
3. If it is necessary to remove the plugs from each end of the shaft, drill or pierce the plug on one end. Use a steel rod to knock out the plug on the

opposite end. Working from the open end, knock out the remaining plug.

### ASSEMBLY

1. All valves, valve stems and valve guides are to be lubricated with heavy oil MS. The valve tips are to have Lubriplate or equivalent applied. The lubricant is to be applied before installation.

All rocker arms, rocker arm shafts or fulcrum seats are to be lubricated with heavy oil MS before installation.

2. If the plugs were removed from the ends of the shaft, use a blunt tool or large diameter pin punch and install a plug, cup side out, in each end of the shaft.

3. Install the spring washer and pin on one end of the shaft.

4. Install the valve rocker arms, supports, and springs in the order shown in Fig. 12. Be sure the oil holes in the shaft are facing downward. Complete the assembly by installing the remaining spring washer and pin.

### CYLINDER HEAD

### REMOVAL

1. Drain the cooling system.

Feeler Gauge

Tool-6513-K

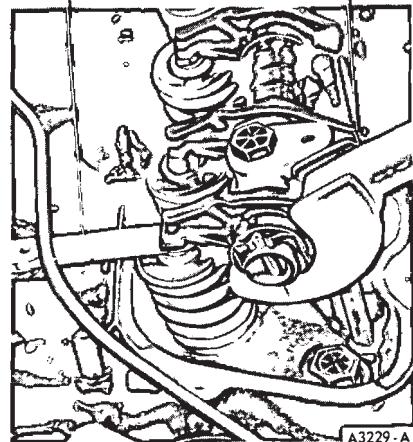


FIG. 10—Checking Valve Clearance

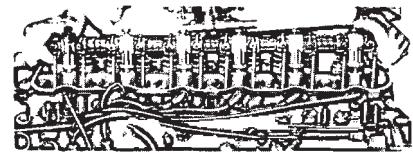


FIG. 11—Valve Rocker Arm Shaft Removal

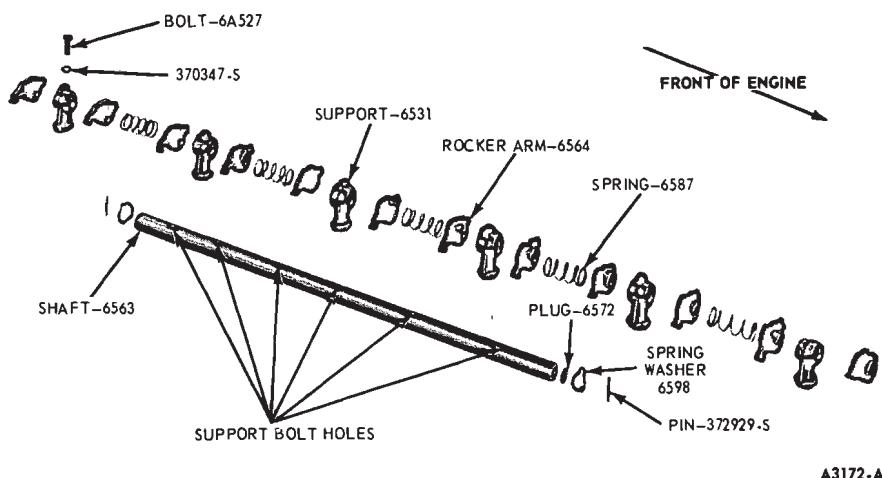


FIG. 12—Valve Rocker Arm Shaft Assembly

Remove the air cleaner. Disconnect the radiator upper hose at the engine.

2. Disconnect the muffler inlet pipe at the exhaust manifold. Pull the muffler inlet pipe down. Remove the gasket.

3. Disconnect the accelerator retracting spring. Disconnect the accelerator rod at the carburetor.

4. Disconnect the transmission kickdown rod. Disconnect the accelerator linkage at the bellcrank assembly.

5. Disconnect the fuel inlet line at the fuel filter hose, and the distributor vacuum lines. Disconnect vacuum lines as necessary for accessibility and identify them for proper connection.

6. Disconnect the distributor vacuum line at the distributor. Disconnect the carburetor fuel inlet line at the fuel pump. Remove the lines as an assembly.

7. Disconnect the spark plug wires at the spark plugs and the temperature sending unit wire at the sending unit.

8. Remove the crankcase ventilation system.

9. Remove the valve rocker arm cover.

10. Remove the valve rocker arm shaft assembly. Remove the valve push rods in sequence (Fig. 13).

11. Remove the remaining cylinder head bolts and remove the cylinder head. Do not pry between the cylinder head and block as the gasket surfaces may become damaged.

## INSTALLATION

1. Clean the head and block gasket surfaces. (Refer to Part 21-01 for cleaning and inspection procedures.) If the cylinder head was removed for

a gasket change, check the flatness of the cylinder head and block. Install guide studs at each end of the cylinder block (Fig. 14).

2. On a 170 or 250 CID six engine, apply cylinder head gasket sealer to both sides of a new gasket. Spread the sealer evenly over the entire gasket surface. Do not apply sealer to a 200 CID Six engine head gasket. Composition head gaskets are to be installed without sealer. Position the gasket over the guide studs on the cylinder block.

3. Install a new gasket on the flange of the muffler inlet pipe.

4. Lift the cylinder head over the guides and slide it down carefully, guiding the exhaust manifold studs into the muffler inlet pipe.

5. Install, but do not tighten two bolts at opposite ends of the head to hold the head and gasket in position. Remove the guides and install the remaining bolts.

6. The cylinder head bolts are tightened in three progressive steps. Torque all the bolts in sequence (Fig. 15) to 55 ft-lbs, then to 65 ft-lbs, and finally to specifications. When cylinder head bolts have been tightened following this procedure, it is not necessary to retorque the bolts after extended operation. However, on cylinder heads with composition gaskets, the bolts may be checked and retorqued, if desired.

7. Apply Lubriplate to both ends of the push rods. Install the push rods in the original bores, positioning the lower end of the rods into the tappet sockets. Apply Lubriplate to the valve stem tips and to the rocker arm pads.

8. Install the valve rocker arm shaft assembly following procedures under Valve Rocker Arm Shaft In-

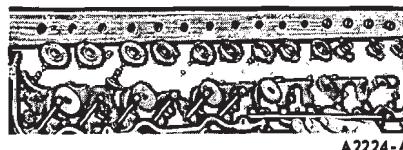


FIG. 13—Valve Push Rod Removal

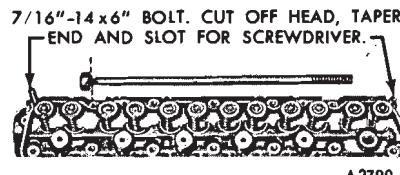


FIG. 14—Cylinder Head Guide Studs

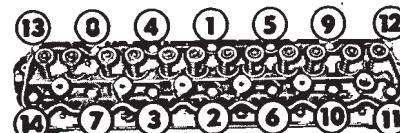


FIG. 15—Cylinder Head Bolt Torque Sequence

stallation.

Check the valve clearance, following the procedure outlined under Valve Clearance Adjustment.

9. Install the muffler inlet pipe lock washers and attaching nuts. Torque the nuts to specifications.

10. Connect the radiator upper hose at the coolant outlet housing.

11. Position the distributor vacuum line and the carburetor fuel inlet line on the engine. Connect the fuel line at the fuel filter using a new clamp; then connect the distributor vacuum line at the carburetor.

12. Connect the accelerator linkage at the bellcrank assembly. Connect the transmission kickdown rod.

13. Connect the accelerator rod retracting spring. Connect the accelerator rod at the carburetor.

14. Connect the distributor vacuum line at the distributor. Connect the carburetor fuel inlet line at the fuel pump. Connect all vacuum lines using previous identification for proper connection.

15. Connect the temperature sending unit wire at the sending unit. Connect the spark plug wires. Be sure the wires are forced all the way down into their sockets.

16. Fill and bleed the cooling system.

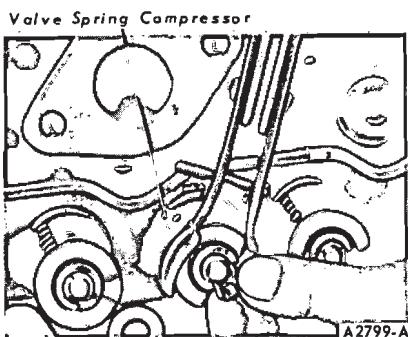


FIG. 16—Compressing Valve Spring—On Bench

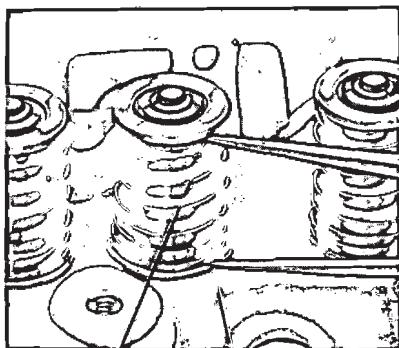


FIG. 17—Typical Valve Assembly

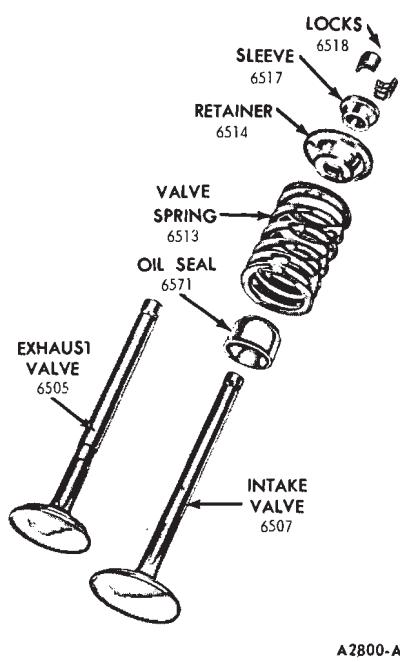


FIG. 18—Valve Spring Assembled Height

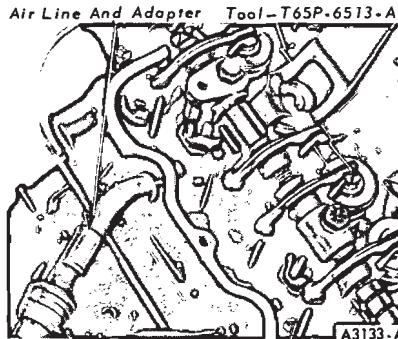


FIG. 19—Compressing Valve Spring—In Chassis

3. Remove the sleeve, spring retainer, stem seal, and valve. Discard the valve stem seals. Identify all valve parts. If the cylinder head is to be replaced, remove the manifold assembly.

#### ASSEMBLY

1. Clean, inspect and repair all parts before assembly. If the cylinder head is being replaced, install the manifold assembly. Lubricate the valve guides and valve stems with engine oil. Apply Lubriplate to the tip of the valve stems.

2. Install each valve (Fig. 17) in the valve guide from which it was removed or to which it was fitted. Install a new stem seal on the valve.

3. Install the valve spring assembly over the valve. Install the spring retainer and sleeve.

4. Compress the spring and install the retainer locks (Fig. 16).

5. Measure the assembled height of the valve spring from the surface of the cylinder head spring pad to the

underside of the spring retainer with dividers (Fig. 18).

6. Check the dividers against a scale. If the assembled height is greater than specifications, install the necessary 0.030-inch thick spacer(s) between the cylinder head spring pad and the valve spring to bring the assembled height to the recommended dimension. Do not install spacers unless necessary. Use of spacers in excess of recommendations will result in overstressing the valve springs and overloading the camshaft lobes which would lead to spring breakage and worn camshaft lobes.

#### VALVE SPRING, RETAINER AND STEM SEAL REPLACEMENT

Broken valve springs or leaking valve stem seals and retainer may be replaced without removing the cylinder head, provided damage to the valve or valve seat has not occurred.

1. Remove the air cleaner. Remove the crankcase ventilation regulator valve from the valve rocker arm cover. Remove the valve rocker arm cover. Remove the applicable spark plug.

2. Loosen the valve rocker arm shaft support bolts two turns at a time, in sequence, until the valve spring pressure is relieved. Remove both valve push rods of the cylinder to be serviced.

3. Install an air line with an adapter in the spark plug hole.

4. Tighten the attaching bolts just enough to seat the rocker arm shaft supports on the cylinder head. Push the rocker arm to one side and secure it in this position (Fig. 19). To move the rocker arm on either end of the shaft, it will be necessary to remove the retaining pin and spring washer and slide the rocker arm off the shaft.

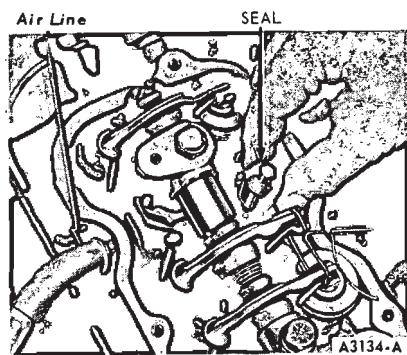
5. Turn on the air supply. Air pressure may turn the crankshaft until the piston reaches the bottom of the stroke. Using the valve spring compression tool shown in Fig. 19, compress the valve and remove the valve spring retainer locks, the sleeve, spring retainer and the valve spring. If air pressure fails to hold the valve in the closed position during this operation, it can be presumed that the valve is not seating or is damaged. If this condition occurs, remove the cylinder head for further inspection.

6. Remove the valve stem seal (Fig. 20). If air pressure has forced the piston to the bottom of the cylinder, any removal of air pressure will allow the valve(s) to fall into the cylinder. A

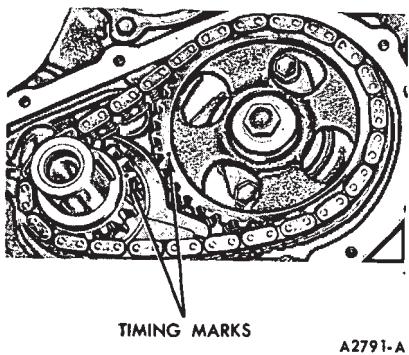
#### DISASSEMBLY

1. Remove deposits from the combustion chambers and valve heads with a scraper and a wire brush before removing the valves. Be careful not to scratch the cylinder head gasket surfaces.

2. Compress the valve springs (Fig. 16). Remove the valve retainer locks and release the spring. If the valve locks are stuck, place a piece of steel tubing (3/4-inch OD, 1/2-inch ID and 3-inches long) over the end of the valve stem squarely against the sleeve surface. Tap the tube with a steel hammer to dislodge the locks.



**FIG. 20—Removing Valve Stem Seal**



**FIG. 21—Aligning Timing Marks**

rubber band, tape or string wrapped around the end of the valve stem will prevent this condition and will still allow enough travel to check the valve for binds.

7. Install a new valve stem seal. Position the spring over the valve. Install the spring retainer and sleeve. Compress the valve spring and install the valve spring retainer locks.

8. Apply Lubriplate to both ends of the push rod, the valve and push rod ends of the rocker arm, and the valve stem tip. Remove the rocker arm shaft and install the push rod(s), making sure the lower end of the rod is positioned in the valve lifter push rod cup.

9. Remove the wire securing the valve rocker arm and slide the rocker arm into position. If an end valve rocker arm was removed, slide it into position on the shaft and install the spring washer and retainer pin. Turn off the air and remove the air line and adapter. Install the spark plug and spark plug wire.

10. Install the rocker arm shaft by following the instructions under Rocker Arm Shaft Assembly Installation.

11. Clean the valve rocker arm cover and cylinder head gasket surfaces. Coat one side of a new gasket

with an oil-resistant sealer and lay the cemented side of the gasket on the cover. Install the cover making sure the gasket seats evenly around the head. Tighten the cover attaching bolts in two steps. First, torque the bolts to specifications. Two minutes later, torque the bolts to the same specifications.

12. Insert the regulator valve (with the vent hose attached) into the valve rocker arm cover mounting grommet. Install the air cleaner.

## WATER PUMP

### REMOVAL

1. Drain the cooling system.
2. Remove the power steering and air conditioner drive belts, if so equipped.
3. Disconnect the radiator lower hose at the water pump. Remove the drive belt, fan, or fan and drive clutch, and water pump pulley.
4. Disconnect the heater hose at the water pump.
5. Remove the water pump.

### INSTALLATION

Before a water pump is re-installed, check it for damage. If it is damaged, replace it.

1. If a new water pump is to be installed, remove the heater hose fitting from the old pump and install it on the new pump. Clean the gasket surfaces on the water pump and cylinder block. A 250 CID six engine originally uses a one piece gasket for the cylinder front cover and water pump. Trim away the old gasket at the edge of the cylinder front cover. Use a water pump service gasket to replace it.

2. Coat the new gasket on both sides with water-resistant sealer and position it on the cylinder block.

3. Position the water pump and install the lock washers and attaching bolts (the alternator adjusting arm is secured by one water pump bolt). Torque the bolts to specifications.

4. Connect the radiator lower hose and the heater hose to the water pump.

5. Install the water pump pulley and fan or fan and drive clutch. Torque the bolts evenly and alternately to specifications.

6. Install the power steering and air conditioner drive belts, if so equipped, and adjust the tension to specifications.

7. Fill and bleed the cooling system. Operate the engine until normal operating temperature is reached. Check for leaks and check the coolant level.

## CYLINDER FRONT COVER AND TIMING CHAIN

### REMOVAL

1. Drain the cooling system and the crankcase. Disconnect the radiator upper hose at the coolant outlet housing and the radiator lower hose at the water pump. On a vehicle with automatic transmission, disconnect the transmission oil cooler lines from the radiator.

2. Remove the radiator. Remove the drive belt, fan and pulley. On a vehicle with air conditioning remove the condenser retaining bolts and position the condenser forward. Do not disconnect the refrigerant lines. Remove the compressor drive belt. If so equipped, remove the accessory drive pulley. Using Tool T58P-6316-B, remove the crankshaft damper.

3. On a 170 or 200 CID engine, remove the cylinder front cover attaching screws from the cover and from the oil pan. Pry the top of the front cover away from the block slightly and using a thin bladed knife cut the oil pan gasket flush with the front face of the cylinder block.

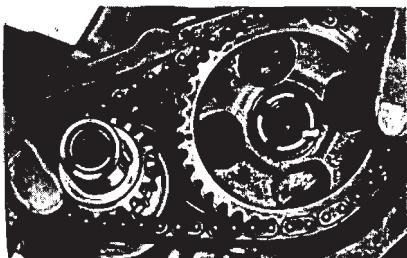
4. On a 250 CID engine, remove the oil pan. Remove the cylinder front cover.

5. Clean any gasket material from the surfaces.

6. Rotate the crankshaft in a clockwise direction (as viewed from the front) to take up the slack on the left side of the chain.

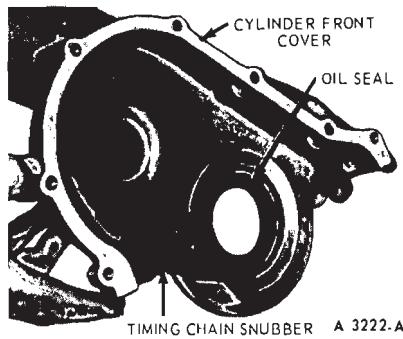
7. Establish a reference point on the block and measure from this point to the chain. Rotate the crankshaft in the opposite direction to take up the slack on the right side of the chain. Force the left side of the chain out with the fingers and measure the distance between the reference point and the chain. The deflection is the difference between the two measurements. If the deflection exceeds  $1/2$  inch, replace the timing chain and sprockets.

8. Crank the engine until the timing marks are aligned as shown in Fig. 21. Remove the camshaft sprocket attaching bolt and washer. Slide both sprockets and timing chain forward and remove them as an assembly (Fig. 22).



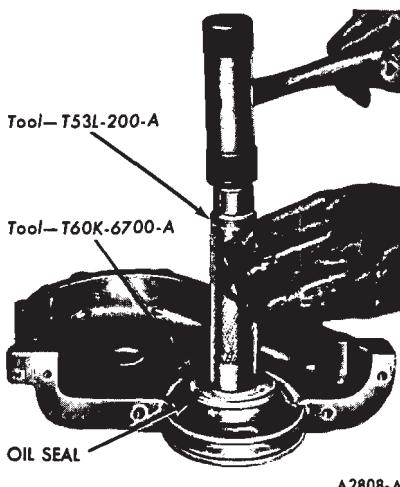
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**FIG. 22—Timing Chain and Sprockets Removal**



A 3222-A

**FIG. 24—Timing Chain Snubber Installation—250 CID Six**



A2808-A

**FIG. 23—Crankshaft Front Oil Seal Replacement**

#### FRONT OIL SEAL

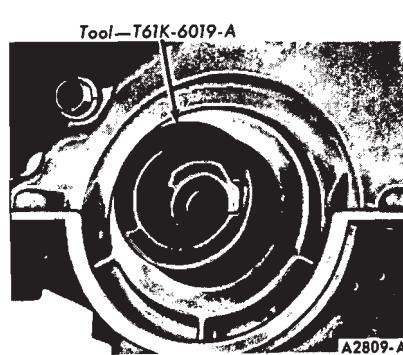
1. Drive out the oil seal with a pin punch. Clean the recess in the cover.
2. Coat a new seal with grease and install the seal. Drive the seal in until it is fully seated in the recess, (Fig. 23). Check the seal after installation to be sure the spring is properly positioned in the seal.

#### INSTALLATION

1. Clean and inspect all parts before installation. Oil the timing chain after installing it on the cam-shaft and crankshaft. Be sure the timing marks on the sprockets and chain are positioned as shown in Fig. 21. Install the camshaft sprocket attaching bolt and washer. Torque the bolt to specifications.

2. Apply oil-resistant sealer to a new cylinder front cover gasket and position the gasket on the cylinder front cover. Apply sealer to the exposed area of the gasket.

On a 170 or 200 CID engine, coat



**FIG. 25—Cylinder Front Cover**

the gasket surface of the oil pan with oil resistant sealer. Cut and position the required portions of a new gasket on the oil pan. Apply sealer to the exposed areas of the gasket, including the corners where they contact the front cover gasket.

On a 250 CID engine, install the timing chain snubber in the front cover.

3. Install the cylinder front cover using the tool shown in Fig. 25.

On a 250 CID engine, no adjustment is needed on the chain snubber (Fig. 25) as this is automatically obtained during front cover alignment. Torque the attaching bolts to specifications.

4. Lubricate the hub of the crank-shaft damper with Lubriplate to prevent damage to the seal during installation or initial engine start. Using tool T52L-6306-AEE, install the crankshaft damper. Torque the attaching bolt to specifications.

5. On a 250 CID engine install the oil pan and related parts.

6. Install the fan, pulley and drive belt. Adjust the drive belt.

7. Install the radiator. Connect the radiator upper and lower hoses.

If any coolant has entered the oil pan when separating the cylinder front cover from the block, the crankcase oil should be drained and refilled with the proper grade and quantity of engine oil before starting the engine.

8. Fill and bleed the cooling system.

9. Start the engine and check the ignition timing. Operate the engine at fast idle and check all hose connections and gaskets for leaks.

#### CAMSHAFT

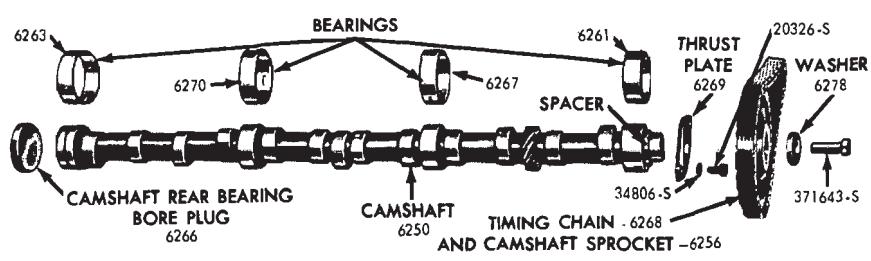
The camshaft and related parts are shown in Fig. 26.

#### REMOVAL

1. Drain the cooling system and the crankcase. Remove the air cleaner.

2. Disconnect the radiator hoses from the coolant outlet housing and the water pump. Remove the radiator. Remove the grille. On a vehicle with air conditioning, remove the condenser attaching bolts, and position the condenser to one side. Do not disconnect the condenser refrigerant lines.

3. On a Mustang, remove the grille center support bracket. Remove the bolts from the left side of the upper and lower stone shields. If necessary loosen the bolts on the right side of



A2804-A

**FIG. 26—Camshaft and Related Parts**

the stone shields and raise the stone shields out of the way to remove the camshaft.

4. Disconnect the accelerator rod retracting spring. Disconnect the accelerator rod from the carburetor.

5. Disconnect the fuel inlet line at the fuel filter, and the distributor vacuum line from the carburetor.

6. Disconnect the muffler inlet pipe from the exhaust manifold. Pull the muffler inlet pipe down. Remove the gasket.

7. Disconnect the distributor vacuum line from the distributor. Disconnect the carburetor fuel inlet line from the fuel pump. Remove the lines as an assembly.

8. Disconnect the spark plug wires from the spark plugs and the coil high tension lead at the coil. Remove the distributor cap and spark plug wires as an assembly. Disconnect the primary wire from the coil and remove it from the retaining clip on the cylinder head.

9. Disconnect the engine temperature sending unit wire from the sending unit. Disconnect the flexible fuel line from the fuel tank line and plug the line. Remove the distributor, the fuel pump, and the oil filter.

10. Remove the crankcase vent hose, regulator valve, valve rocker arm cover and cylinder head by following steps 8 thru 11 under Cylinder Head Removal.

11. Using a magnet, remove the valve lifters and keep them in order so that they can be installed in the original location (Fig. 27). If the valve lifters are stuck in the bores by excessive varnish, etc., it may be necessary to use a claw-type tool to remove the lifters.

12. Loosen and remove the drive belt, fan and pulley. Remove the crankshaft damper using tool T58P-6316-B.

13. Remove the oil level dipstick. Remove the oil pan. Remove the oil

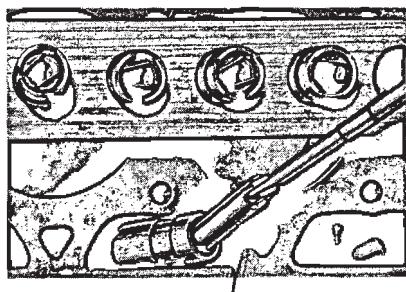


FIG. 27—Removing Valve Lifter

pump and inlet tube assembly.

14. Remove the cylinder front cover and gasket.

15. Push the camshaft toward the rear of the engine. Install a dial indicator so that the indicator point is on the camshaft sprocket cap screw (Fig. 28). Zero the dial indicator. Position a large screw driver between the camshaft sprocket and the block. Pull the camshaft forward and release it. Compare the dial indicator reading with specifications. If the end play is excessive, replace the thrust plate.

16. Remove the dial indicator. Remove the timing chain and sprockets as detailed under Cylinder Front Cover and Timing Chain Removal.

17. Remove the camshaft thrust plate. Carefully remove the camshaft by pulling it toward the front of the engine. Use caution to avoid damaging the journals and lobes.

## INSTALLATION

1. Clean the oil passage that feeds the rocker arm shaft by blowing compressed air into the opening in the block. Camshaft lobes are to be coated with Lubriplate or equivalent and the journals lubricated with heavy oil MS before installation. Carefully slide the camshaft through the bearings.

2. Install the thrust plate with the oil groove toward the rear of the engine and torque the attaching bolts to specifications. Replace the crankshaft front oil seal.

3. Install the sprockets and timing chain, cylinder front cover and crankshaft damper as detailed under Cylinder Front Cover and Timing Chain Installation.

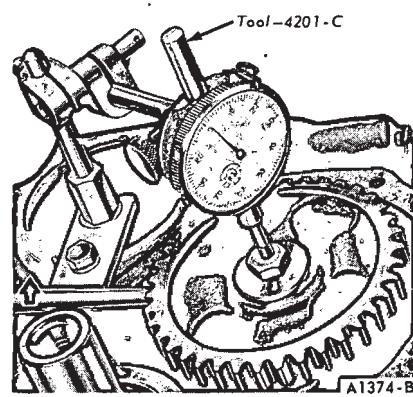


FIG. 28—Checking Camshaft End Play

4. Clean the oil pump inlet tube screen, oil pan, and block gasket surfaces. Prime the oil pump by filling the inlet opening with oil and rotate the pump shaft until oil emerges from the outlet opening. Install the pump inlet tube. Install the oil pump and oil pan. Install the oil level dipstick.

5. Install the fan, fan pulley and drive belt. Adjust the belt tension. Install the radiator and the grille.

On a Mustang, install the bolts in the upper and lower stone shields, and install the grille, grille center support bracket and bumper.

6. Dip the base of the valve lifter body in Lubriplate. Tappets or lifters and bores are to be lubricated with heavy oil MS before installation. Install the valve lifters in their original bores.

7. Install the cylinder head, push rods and the valve rocker arm shaft assembly by following the procedure under Cylinder Head Installation.

8. Using a new gasket, install the fuel pump and connect the flexible fuel line. Install the oil filter.

9. Position the No. 1 piston at TDC after the compression stroke. Position the distributor in the block with the rotor at the No. 1 firing position and the breaker points open. Install the distributor hold down clamp.

10. Connect the engine temperature sending unit wire. Connect the coil primary wire. Install the distributor cap. Connect the spark plug wires and the coil high tension lead.

11. Install the carburetor fuel inlet line, using a new clamp on the filter tubing. Connect the distributor vacuum line to the carburetor.

12. On a vehicle with air conditioning, position the condenser and install the attaching bolts. Install the radiator and connect the radiator upper and lower hoses.

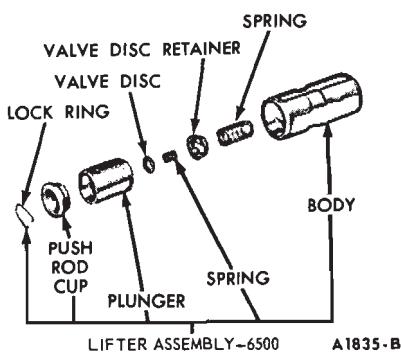
13. Connect the accelerator rod retracting spring. Connect the accelerator rod at the carburetor.

14. Fill and bleed the cooling system. Fill the crankcase.

15. Start the engine and check and adjust the ignition timing. Connect the distributor vacuum line to the distributor. Check for coolant and oil leaks. Adjust the engine idle speed and the idle fuel mixture.

## CAMSHAFT REAR BEARING BORE PLUG

1. On a vehicle with a manual-shift transmission, slide the transmission to the rear and remove the clutch pres-



**FIG. 29—Typical Valve Lifter Assembly**

sure plate and disc following the procedure in Volume One, Group 16—Clutch.

On a vehicle with automatic transmission, remove the transmission and converter housing following the procedure in Volume One, Group 17—Automatic Transmission.

2. Remove the flywheel attaching bolts and remove the flywheel and engine rear cover plate.

3. Install a new plug as detailed in Part 21-01, In-Vehicle Adjustments and Repairs.

4. Install the engine rear cover plate, apply oil-resistant sealer to the flywheel bolts and install the flywheel.

On a vehicle with a manual-shift transmission, install the clutch pressure plate, disc, and transmission following the procedure in Volume One, Group 16—Clutch.

On a vehicle with automatic transmission install the transmission and converter housing following the procedure in Volume One, Group 17—Automatic Transmission.

## **HYDRAULIC VALVE LIFTERS**

Before replacing a hydraulic valve lifter for noisy operation, be sure the noise is not caused by improperly adjusted valve clearance or by worn rocker arms or push rods.

### **REMOVAL**

1. Remove the cylinder head and related parts following the procedure under Cylinder Head Removal.

2. Using a magnet, remove the valve lifters (Fig. 27). Place the lifters in a rack so they can be installed in the original positions.

If the lifters are stuck in their bores by excessive varnish or gum, it may be necessary to use a plier-type tool or claw-type tool to remove the lifters. Rotate the lifter back and forth

to loosen the gum and varnish which may have formed on the lifter.

The internal parts of each hydraulic valve lifter assembly are matched sets. Do not intermix the parts. Keep the assemblies intact until they are to be cleaned. If the valve lifters are to be tested or disassembled and cleaned, follow the procedures in Part 21-01, Engine Tests. If a hydraulic valve lifter has been disassembled and cleaned, be sure to fill it with test fluid before installing it in the engine. New valve lifters already contain test fluid.

### **INSTALLATION**

1. Install new (or cleaned) hydraulic valve lifters through the push rod openings with a magnet (Fig. 27).

2. Install the cylinder head and related parts.

### **DISASSEMBLY**

Each valve lifter is a matched assembly; therefore, the parts are not interchangeable. Disassemble and assemble each lifter carefully, keeping the assemblies in proper sequence so they will be installed in the original bores.

1. Grasp the lock ring with needle nose pliers to release it from the groove. It may be necessary to depress the plunger to fully release the lock ring.

2. Remove the push rod cup, plunger and spring.

3. Invert the plunger assembly and remove the check valve retainer by carefully prying up on it with a screwdriver. Remove the check valve and spring.

### **ASSEMBLY**

A typical hydraulic valve lifter assembly is shown in Fig. 29.

1. Place the plunger in the inverted position on a clean work bench.

2. Place the check valve in position over the oil hole on the bottom of the plunger. Set the check valve spring on top of the check valve.

3. Position the check valve retainer over the check valve and spring and push the retainer down into place on the plunger.

4. Place the plunger spring and then the plunger (open end up) into the tappet body.

5. Place the push rod seat in the plunger.

6. Depress the plunger and position the closed end of the lock ring in the lifter body groove. Release the plung-

er; then depress it again to fully seat the lock ring.

### **MAIN AND CONNECTING ROD BEARINGS**

**Do not file or lap bearing caps or use bearing shims to obtain the proper bearing clearance.**

Main bearings are available for service in standard sizes and 0.001 and 0.002 inch undersize. Undersize bearings, which are not selective fit, are available for use on journals that have been refinished.

### **MAIN BEARINGS**

#### **Removal**

1. Drain the crankcase. Remove the oil level dipstick. Remove the oil pan and related parts.

2. Remove the oil pump inlet tube assembly and the oil pump.

3. Replace one bearing at a time, leaving the other bearings securely fastened. Remove the main bearing cap to which new bearings are to be installed.

4. Insert the upper bearing removal tool (tool 6331) in the oil hole in the crankshaft.

5. Rotate the crankshaft in the direction of engine rotation to force the bearing out of the block.

#### **Installation**

1. Clean crankshaft journals. Inspect journals and thrust faces (thrust bearing) for nicks, burrs or bearing pick-up that would cause premature bearing wear. When replacing standard bearings with new bearings, fit the bearing to minimum specified clearance. If the desired clearance cannot be obtained with a standard bearing, try one half of a 0.001 or 0.002 inch undersize in combination with a standard bearing to obtain the proper clearance.

2. To install the upper main bearing, place the plain end of the bearing over the shaft on the locking tang side of the block and partially install the bearing so that tool 6331 can be inserted in the oil hole in the crankshaft. With tool 6331 positioned in the oil hole in the crankshaft, rotate the crankshaft in the opposite direction of engine rotation until the bearing seats itself. Remove the tool.

3. Install the cap bearing.

4. Select fit the bearings for proper clearance following procedures under Fitting Main and Connecting Rod

Bearings in Part 21-01.

5. If the rear main bearing is replaced, replace the oil seal in the rear main bearing cap as described under Crankshaft Rear Oil Seal in Part 21-01.

6. After the bearing has been fitted, apply a light coat of engine oil to the journal and bearings, then install the bearing cap. Torque the cap bolts to specifications. Repeat the procedure for the remaining bearings that require replacement.

7. If the thrust bearing cap (No. 5 main bearing) has been removed, install it as follows:

Install the thrust bearing cap with the bolts finger-tight. Pry the crankshaft forward against the thrust surface of the upper half of the bearing (Fig. 46). Hold the crankshaft forward and pry the thrust bearing cap to the rear (Fig. 46). This will align the thrust surfaces of both halves of the bearing. Retain the forward pressure on the crankshaft. Torque the cap bolts to specification.

8. Clean the oil pump inlet tube screen. Prime the oil pump by filling the inlet opening with oil and rotating the pump shaft until oil emerges from the outlet opening. Then install the oil pump and the inlet tube assembly.

9. Position the oil pan gaskets on the oil pan. Position the oil pan front seal on the cylinder front cover. Position the oil pan rear seal on the rear main bearing cap. Install the oil pan and related parts. Install the oil level dipstick.

10. Fill the crankcase. Start the engine and check for oil pressure. Operate the engine at fast idle and check for oil leaks.

## CONNECTING ROD BEARINGS

### Removal

1. Follow steps 1 and 2 under Main Bearing Replacement.

2. Turn the crankshaft until the connecting rod to which new bearings are to be fitted is down. Remove the connecting rod cap. Remove the bearing inserts from the rod and cap.

### Installation

1. Be sure the bearing inserts and the bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause a failure.

2. Clean crankshaft journal. When replacing standard bearings with new

bearings, fit the bearing to minimum specified clearance.

3. Install the bearing inserts in the connecting rod and cap with the tangs fitting in the slot provided.

4. Pull the connecting rod assembly down firmly on the crankshaft journal.

5. Select fit the bearings for proper clearance following procedures under Fitting Main and Connecting Rod Bearings in Part 21-01.

6. After bearing has been fitted, clean and apply light coat of engine oil to journal and bearings. Install connecting rod cap. Be sure connecting rod bolt heads are properly seated in connecting rod. Torque nuts to specifications.

7. Repeat the procedure for the remaining connecting rods that require new bearings.

8. Follow the procedure under Main Bearings.

## PISTONS AND CONNECTING RODS

### REMOVAL

1. Drain the cooling system and the crankcase.

2. Refer to Cylinder Head Removal and remove the cylinder head and related parts.

3. Remove the oil pan and related parts. Remove the oil pump inlet tube and the oil pump.

4. Turn the crankshaft until the piston to be removed is at the bottom of the stroke, then place a cloth on the piston head to collect the cuttings. Remove any ridge and/or deposits from the upper end of the cylinder bores. Remove the cylinder ridge with a ridge cutter. Follow the instructions furnished by the tool manufacturer. Never cut into the ring travel area in excess of  $1/32$  inch when removing ridges.

5. Make sure all the connecting rod caps are marked so that they can be installed in the original positions. Remove the connecting rod cap.

6. Push the connecting rod and piston assembly out the top of the cylinder with the handle end of a hammer. Avoid damage to the crankpin or the cylinder wall when removing the piston and rod.

### INSTALLATION

1. Clean the oil pump inlet tube screen, and the oil pan and block gasket surfaces.

2. Oil the piston rings, pistons and

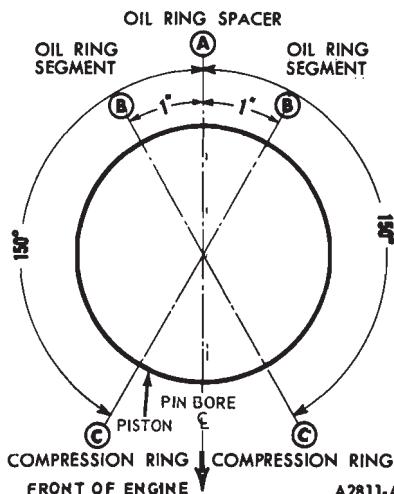


FIG. 30—Piston Ring Gap Spacing

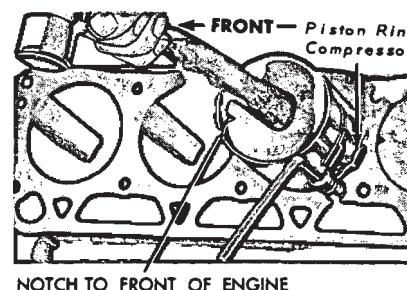


FIG. 31—Piston Installation

cylinder walls with light engine oil.

3. Be sure to install the pistons in the same cylinders from which they were removed, or to which they were fitted. The connecting rod and bearing caps are numbered from 1 to 6, beginning at the front of the engine. The numbers on the connecting rod and bearing cap must be on the same side when installed in the cylinder bore. If a connecting rod is transferred from one block or cylinder to another, new bearings should be fitted and the connecting rod should be numbered to correspond with the new cylinder.

4. Make sure the ring gaps are properly spaced around the circumference of the piston (Fig. 30). Install a piston ring compressor on the piston and push the piston in with a hammer handle until it is slightly below the top of the cylinder (Fig. 31). Be sure to guide the connecting rods to avoid damaging the crankshaft journals. Install the piston with the notch in the piston head toward the front of the engine.

5. Check the clearance of each

bearing, following the procedure under Connecting Rod Bearings.

6. After the bearings have been fitted, apply a light coat of engine oil to the journals and bearings.

7. Turn the crankshaft throw to the bottom of the stroke, then push the piston all the way down until the connecting rod bearing seats on the crankshaft journal. Install the connecting rod cap. Torque the nuts to specifications.

8. After the piston and connecting rod assemblies have been installed, check the connecting rod side clearance on each crankshaft journal (Fig. 32).

9. Prime the oil pump by filling the inlet opening with the oil and rotating the pump shaft until oil emerges from the outlet opening. Install the oil pump and the oil pump inlet tube. Install the oil pan and related parts.

10. Install the cylinder head by following the instructions under Cylinder Head Installation.

11. Fill the crankcase.

12. Start the engine and check for oil pressure. Operate the engine at fast idle and check for oil and coolant leaks.

13. Check and adjust the ignition timing, engine idle speed and the fuel mixture.

14. Install the air cleaner.

## DISASSEMBLY

1. Remove the bearing inserts from the connecting rod and cap.

2. Mark the pistons and pins to assure assembly with the same rod and installation in the same cylinders from which they were removed.

3. Using an arbor press and the tool shown in Fig. 33, press the piston pin from the piston and connecting rod. Remove the piston rings.

## ASSEMBLY

The piston, connecting rod and related parts are shown in Fig. 34. Check the fit of a new piston in the cylinder bore before assembling the piston and piston pin to the connecting rod.

The piston pin bore of a connecting rod and the diameter of the piston pin must be within specifications. Refer to Part 21-09.

1. Apply a light coat of engine oil to all parts. Assemble the piston to the connecting rod with the oil squirt hole in the connecting rod and the indentation in the piston positioned as shown in Fig. 35.

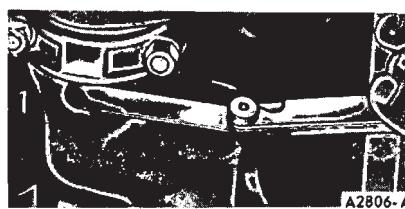


FIG. 32—Typical Connecting Rod Side Clearance

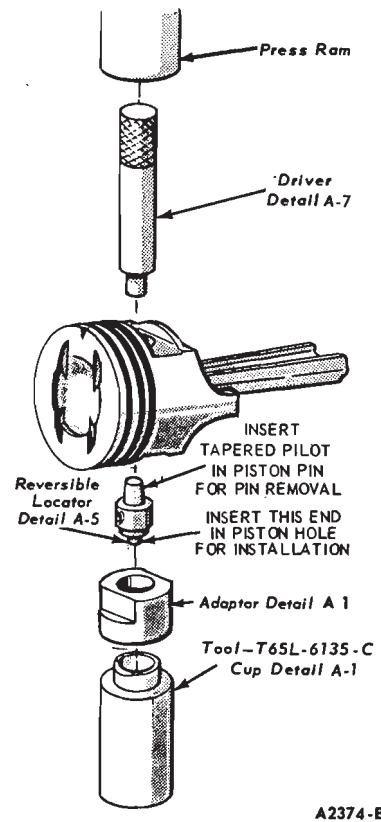
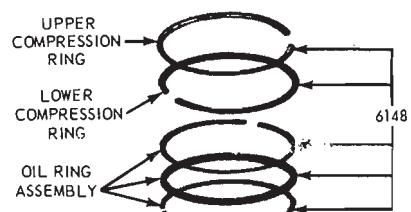


FIG. 33—Removing or Installing Piston Pin

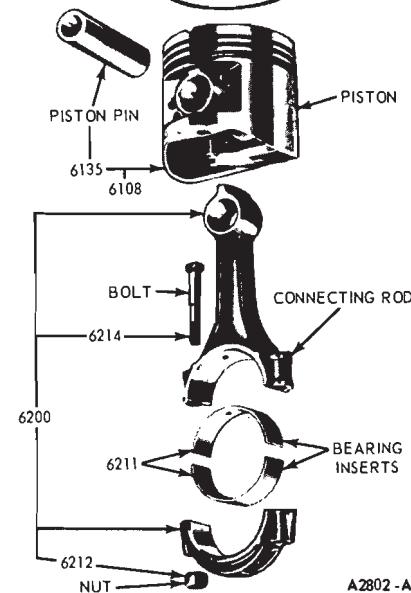


FIG. 34—Typical Piston, Connecting Rod and Related Parts

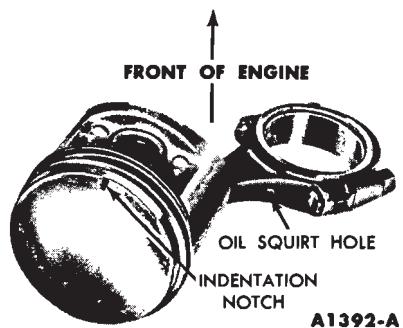


FIG. 35—Typical Piston and Connecting Rod Assembly

binding. Any wear that occurs will form a step at the inner portion of the lower land. If the lower lands have high steps, the piston should be replaced.

6. Be sure the bearing inserts and the bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause a failure. Install the bearing inserts in the connecting rod and cap with the tangs fitting in the slots provided.

2. Start the piston pin in the piston and connecting rod (this may require a very light tap with a mallet). Using an arbor press, press the piston pin through the piston and connecting rod until the pin is centered in the piston (Fig. 33).

3. Check the end gap and spacing (Fig. 30) of all piston rings. They must be within specifications.

4. Follow the manufacturer's instructions (included with the piston ring package) and install the piston rings.

5. Check the ring side clearance of the compression rings with a feeler gauge inserted between the ring and the lower land (Part 21-01). The gauge should slide freely around the entire ring circumference without

## FLYWHEEL

### REMOVAL

1. On a manual-shift transmission, remove the transmission, clutch pressure plate and disc, following the procedures in Volume One, Group 16—Clutch. Do not drain the transmission.

On a vehicle with an automatic transmission, remove the transmission and converter housing following the procedure in Volume One, Group 17—Automatic Transmission. Do not drain the transmission.

2. Refer to Part 21-01, Cleaning and Inspection, for flywheel face runout. Remove the flywheel retaining bolts and remove the flywheel.

### INSTALLATION

1. Clean and inspect all parts before installation. Position the flywheel on the crankshaft flange. Apply oil-resistant sealer to the attaching bolts. Install and torque the bolts in sequence across from each other to specifications.

2. On a manual-shift transmission, install the clutch pressure plate, disc, and the transmission following the procedures in Volume One, Group 16—Clutch.

On a vehicle with automatic transmission, install the converter housing and transmission following the procedure in Volume One, Group 17—Automatic Transmission. It is not necessary to adjust the transmission, when it has been removed only for flywheel removal.

## CLUTCH PILOT BUSHING

Inspection procedures are outlined under Flywheel Cleaning and Inspection in Part 21-01.

### REMOVAL

1. Remove the transmission, clutch pressure plate, and disc following the procedures in Volume One, Group 16—Clutch.

2. Using tools T59L-100-B and T58L-101-A, remove the pilot bushing (Fig. 36).

### INSTALLATION

1. Coat the pilot bushing bore in the crankshaft with a small quantity of wheel bearing lubricant. Avoid using too much lubricant as it may be thrown onto the clutch disc when the

clutch revolves.

2. Using tool T65L-7600-A, install the pilot service bearing (Fig. 37).

3. Install the clutch pressure plate, disc, and the transmission following the procedure in Volume One, Group 16—Clutch.

## OIL FILTER

### REMOVAL

1. Place a drip pan under the filter. Unscrew the filter from the adapter fitting. Clean the adapter filter recess.

### INSTALLATION

1. Coat the gasket on the replacement filter with oil. Position the filter on the adapter fitting. Hand-tighten the filter until the gasket contacts the adapter face, then advance it 1/2 turn.

2. Operate the engine at fast idle, and check for oil leaks. If oil leaks are evident, perform the necessary repairs to correct the leakage. Check the oil level and fill the crankcase if necessary.

## OIL PAN

### REMOVAL

1. Drain the crankcase.

2. Remove the oil level dipstick and the flywheel housing inspection cover.

3. On a Mustang, disconnect the stabilizer bar and pull it downward out of the way. Remove one bolt and loosen the other on the No. 2 crossmember and lower it out of the way.

4. Remove the oil pan and gasket.

5. Remove the oil pump inlet tube and screen assembly.

### INSTALLATION

1. Clean and install the oil pump inlet tube and screen assembly (Fig. 38).

2. Clean the gasket surfaces of the block and oil pan. Be sure to clean the seal retainer grooves in the cylinder block and oil pan. The oil pan has a two-piece gasket. Coat the block surface and the oil pan gasket surface with oil-resistant sealer. Position the oil pan gaskets on the cylinder block (Fig. 39).

3. Position the oil pan front seal on the cylinder front cover (Fig. 39). Be sure the tabs on the seal are over the oil pan gasket.

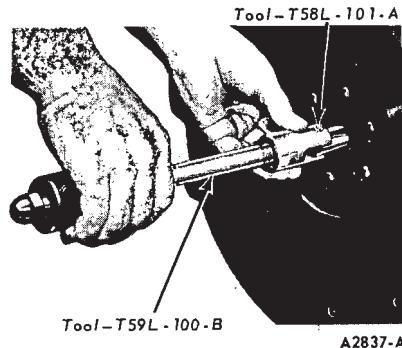


FIG. 36—Removing Clutch Pilot Bushing

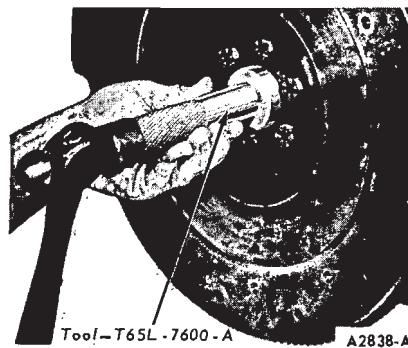


FIG. 37—Installing Clutch Pilot Service Bearing

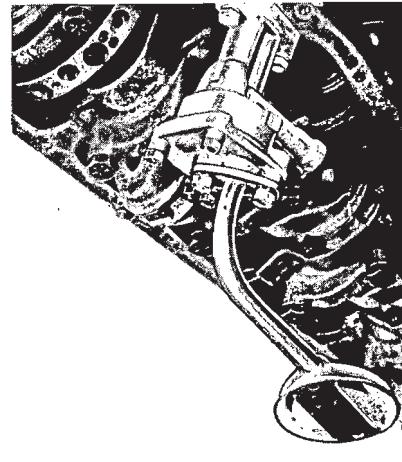
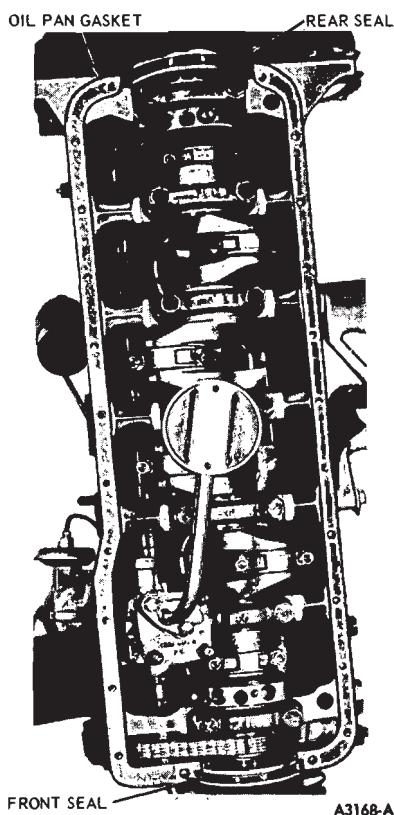


FIG. 38—200 CID Six Oil Pump Inlet Tube Installed

4. Position the oil pan rear seal on the rear main bearing cap (Fig. 39). Be sure the tabs on the seal are over the oil pan gasket.

5. Hold the oil pan in place against the block and install a bolt, finger-tight on each side of the oil pan. Install the remaining bolts. Torque the bolts from the center outward in each direction to specifications.

6. On a Mustang, position the No. 2 crossmember and torque the bolts to specification. Position the stabilizer



**FIG. 40—Typical Oil Pump Assembly**

**FIG. 39—200 CID Six Oil Pan Gaskets and Seals Installed**

bar to the chassis and install the bolts and nuts. Torque to specifications.

7. Install the oil level dipstick. Fill the crankcase with the proper grade and quantity of engine oil. Operate the engine and check for oil leaks.

#### OIL PUMP

##### REMOVAL

1. Remove the oil pan and related parts as outlined under Oil Pan Re-

moval.

2. Remove the oil pump attaching bolts and remove the oil pump, gasket, and intermediate drive shaft.

##### INSTALLATION

1. Prime the oil pump by filling either the inlet or outlet port with engine oil. Rotate the pump shaft to distribute the oil within the pump body.

2. Position the intermediate drive shaft into the distributor socket.

3. Position a new gasket on the pump housing. Insert the intermediate drive shaft into the oil pump. Install the pump and shaft as an assembly. Do not attempt to force the pump into position if it will not seat readily.

The drive shaft hex may be misaligned with the distributor shaft. To align, rotate the intermediate drive

shaft into a new position. Torque the oil pump attaching screws to specifications.

4. Install the oil pan and related parts as outlined under Oil Pan Installation.

#### DISASSEMBLY

1. Remove the oil inlet tube from the oil pump and remove the gasket.

2. Remove the cover attaching screws, and remove the cover. Remove the inner rotor and shaft assembly, and remove the outer race.

3. Insert a self-threading sheet metal screw of the proper diameter into the oil pressure relief valve chamber cap and pull the cap out of the chamber. Remove the spring and plunger.

#### ASSEMBLY

The oil pump assembly is shown in Fig. 40.

1. Clean, inspect and oil all parts thoroughly.

2. Install the oil pressure relief valve plunger, spring, and a new cap.

3. Install the outer race, and the inner rotor and shaft assembly. Be sure the identification mark on the rotor and on the outer race both face to the bottom of the pump. The inner rotor and shaft, and the outer race are serviced as an assembly. One part should not be replaced without replacing the other. Install the cover and torque the cover attaching screws to specifications.

4. Position a new gasket and the oil inlet tube on the oil pump and install the attaching bolts

## 3 ENGINE REMOVAL AND INSTALLATION

#### REMOVAL

1. Remove the hood.
2. Drain the cooling system and the crankcase.
3. Disconnect the closed crankcase ventilation hose. Remove the air cleaner. Disconnect the battery ground cable at the cylinder head, and at the battery. Disconnect the radiator upper hose at the water outlet housing and the radiator lower hose

at the water pump. On a vehicle with automatic transmission disconnect the transmission oil cooler lines from the radiator.

4. Remove the radiator. Remove the fan, spacer, belt and pulley.

5. Disconnect the heater hoses from the water pump and engine block. Disconnect the alternator wires from the alternator, the starter cable from the starter, the accelerator rod and the choke control cable from the

carburetor. On a vehicle with air conditioning, remove the compressor from the mounting bracket, and position it out of the way, leaving the refrigerant lines attached.

6. Disconnect the flexible fuel line at the fuel tank line and plug the fuel tank line.

7. Disconnect the coil primary wire at the coil. Disconnect the oil pressure and the water temperature sending unit wires at the sending units.

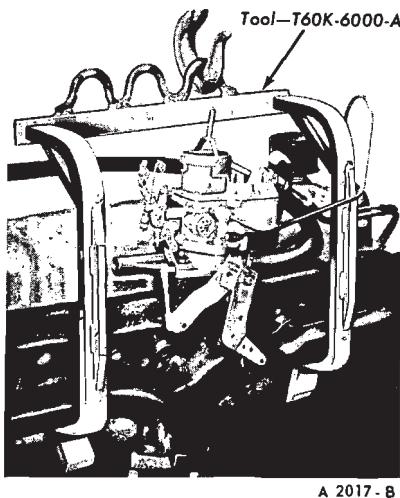


FIG. 41—Engine Lifting Hook

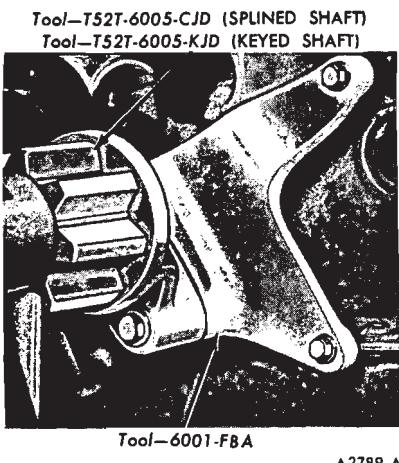


FIG. 42—Engine Work Stand

#### 8. Remove the starter and dust seal.

On a vehicle with a manual-shift transmission, disconnect the clutch retracting spring. Disconnect the clutch equalizer shaft and arm bracket at the underbody rail and remove the arm bracket and equalizer shaft.

9. Raise the vehicle. Remove the flywheel or converter housing upper attaching bolts through the access holes in the underbody.

10. Disconnect the muffler inlet pipe at the exhaust manifold. Loosen

the inlet pipe clamp and slide it off the support bracket on the engine. Disconnect the engine right and left mount at the underbody bracket. Remove the flywheel or converter housing cover.

On a vehicle with a manual-shift transmission, remove the flywheel housing lower attaching bolts.

On a vehicle with automatic transmission, disconnect the converter from the flywheel. Remove the converter housing lower attaching bolts.

11. Lower the vehicle. Support the transmission and flywheel or converter housing with a jack.

12. Attach the engine lifting hook (Fig. 41). Carefully lift the engine out of the engine compartment. Install the engine on a work stand (Fig. 42).

### INSTALLATION

1. Install guide pins in the flywheel or converter housing bolt holes in the rear of the engine. Place a new gasket over the studs of the exhaust manifold.

2. Carefully lower the engine into the engine compartment.

3. Make sure the studs on the exhaust manifold are aligned with the holes in the muffler inlet pipe and the guide pins in the block engage the holes in the flywheel housing.

On a vehicle with automatic transmission, start the converter pilot into the crankshaft.

On a vehicle with a manual-shift transmission, start the transmission main drive gear into the clutch disc. It may be necessary to adjust the position of the transmission in relation to the engine if the input shaft will not enter the clutch disc. **If the engine hangs up after the shaft enters, turn the crankshaft slowly (transmission in gear) until the shaft splines mesh with the clutch disc splines.**

4. Remove the engine lifting hooks. Install the flywheel or converter housing upper attaching bolts.

5. Remove the jack from the transmission. Raise the vehicle.

6. Remove the guide pin and install the flywheel or converter housing

lower attaching bolts.

On a vehicle with automatic transmission, attach the converter to the flywheel and torque the attaching nuts to specifications.

7. Install the flywheel or converter housing dust cover.

On a vehicle with a manual-shift transmission, install the clutch equalizer shaft and arm bracket. Connect the clutch retracting spring.

8. Install the engine left and right mount to the underbody bracket.

9. Remove the plug from the fuel tank line and connect the flexible fuel line to the fuel tank line. Install the exhaust manifold to muffler inlet pipe lock washers and nuts. Torque the nuts to specifications. Position the inlet pipe clamp on the support bracket on the engine and tighten the clamp.

10. Lower the vehicle. Connect the oil pressure and the engine temperature sending unit wires. Connect the coil primary wire. Connect the accelerator rod. Connect and adjust the choke control cable.

11. Install the starter motor and dust seal. Connect the starter cable. Connect the alternator wires. Connect the heater hose at the water pump and engine block. Connect the battery ground cable.

12. Install the pulley, fan, and drive belt. Adjust the drive belt tension. On a vehicle with air conditioning, install the compressor on the mounting bracket, and adjust the belt tension to specifications. Install the radiator. Connect the radiator upper and lower hoses. Fill and bleed the cooling system. Fill the crankcase with the proper grade and quantity of engine oil.

13. Install and adjust the hood.

14. Operate the engine at fast idle and check all gaskets and hose connections for leaks.

On a vehicle with automatic transmission, adjust the transmission control linkage (Group 23, Throttle Linkage).

15. Install the air cleaner and connect the positive closed-type crankcase ventilation hose.

## 4 MAJOR REPAIR OPERATIONS

To perform the operations in this section, it will be necessary to remove the engine from the vehicle and install

it on a work stand.

When installing nuts or bolts that must be torqued (refer to Part 21-09

for torque specifications), oil the threads with light weight engine oil. **Do not oil threads that require oil-**

resistant or water-resistant sealer.

### CRANKSHAFT REMOVAL

The crankshaft and related parts are shown in Fig. 43.

1. Remove the oil level dipstick.
2. Remove the accessory drive pulley (if so equipped). Remove the crankshaft damper retaining bolt and washer. Remove the crankshaft vibration damper using tool T58P-6316-B.
3. Remove the cylinder front cover and air conditioning idler pulley assembly (if so equipped). Remove the cover gasket.

4. Check the timing chain deflection; then remove the timing chain and sprockets as detailed under Cylinder Front Cover and Timing Chain Removal.

5. Invert the engine on the work stand. Remove the flywheel. Remove the oil pan and gasket. Remove the oil pump.

6. Make sure all bearing caps (main and connecting rod) are marked so that they can be installed in their original locations. Turn the crankshaft until the connecting rod from which the cap is being removed is down. Remove the connecting rod cap. Push the connecting rod and pis-

ton assembly up in the cylinder. Repeat for the remaining caps.

7. Remove the main bearing caps.

8. Carefully lift the crankshaft out of the block so that the thrust bearing surfaces are not damaged. Handle the crankshaft with care to avoid possible fracture or damage to the finished surfaces.

### INSTALLATION

1. Remove the rear journal oil seal from the block and rear main bearing cap.

2. Remove the main bearing inserts from the block and bearing caps.

3. Remove the connecting rod bearing inserts from the connecting rods and caps.

4. Clean the rear journal oil seal grooves. Install a new rear journal oil seal in the block and rear main bearing cap. After installation, cut the ends of the seals flush.

5. Apply a thin coating of oil resistant sealer to the rear main bearing cap at the rear of the top mating surface. Do not apply sealer to the area forward of the oil slinger groove.

6. If the crankshaft main bearing journals have been refinished to a definite undersize, install the correct undersize bearings. Be sure the bear-

ing inserts and bearing bores are clean. Foreign material under the inserts will distort the bearing and cause a failure.

7. Place the upper main bearing inserts in position in the bores with the tang fitting the slot provided.

8. Install the lower main bearing inserts in the bearing caps.

9. Carefully lower the crankshaft into place. Be careful not to damage the bearing surfaces.

10. Check the clearance of each main bearing. Select fit the bearings for proper clearance following procedures under Fitting Main and Connecting Rod Bearings in Part 21-01.

11. After the bearings have been fitted, apply a light coat of engine oil to the journals and bearings. Install all the bearing caps, except the thrust bearing cap (No. 5 bearing). Be sure that the main bearing caps are installed in the original locations. Torque the bearing cap bolts to specifications.

12. Install the thrust bearing cap with the bolts finger-tight.

13. Pry the crankshaft forward against the thrust surface of the upper half of the bearing (Fig. 44).

14. Hold the crankshaft forward and pry the thrust bearing cap to the rear (Fig. 44). This will align the

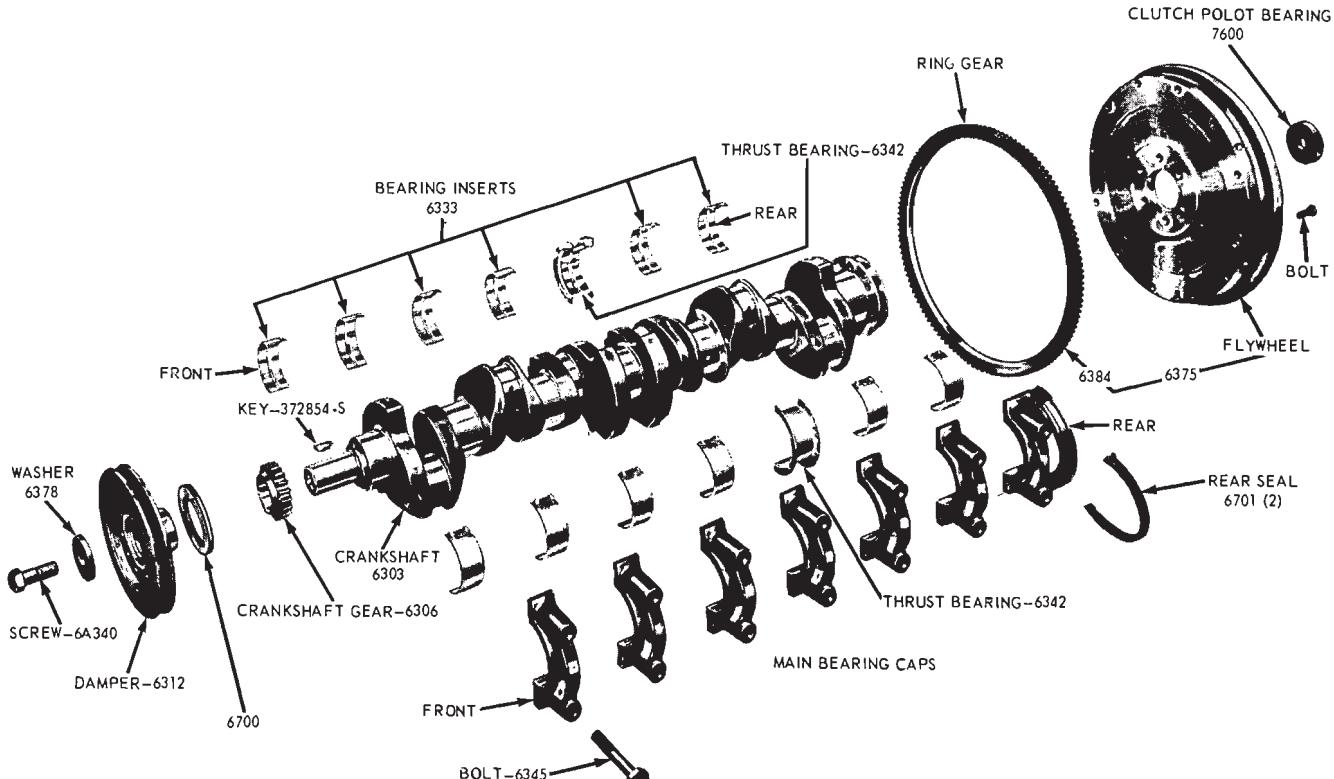
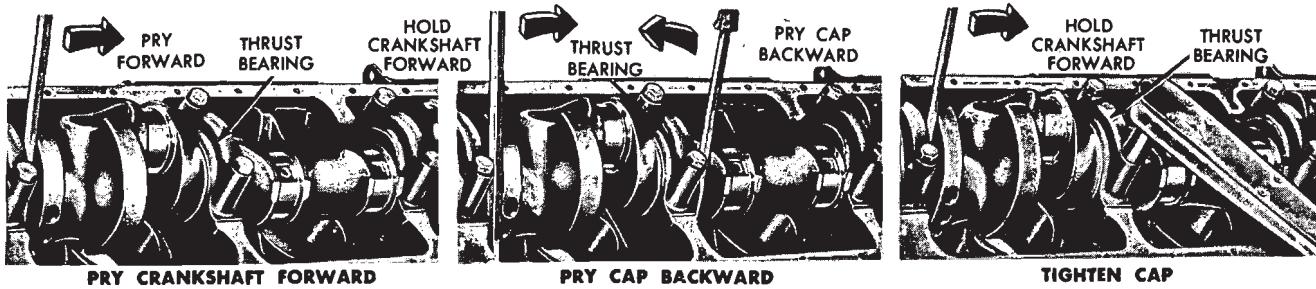


FIG. 43—200 CID Six Crankshaft and Related Parts



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FIG. 44—Typical Thrust Bearing Alignment

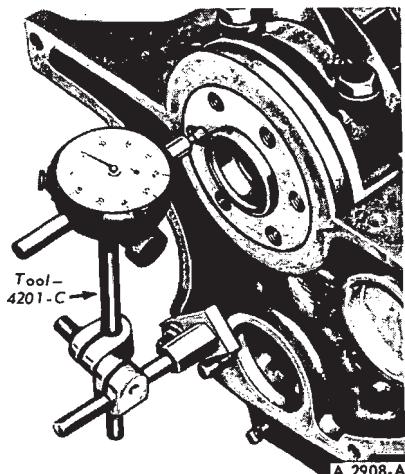


FIG. 45—Crankshaft End Play

thrust surfaces of both halves of the bearing.

15. Retain the forward pressure on the crankshaft. Torque the cap bolts to specifications (Fig. 44).

16. Force the crankshaft toward the rear of the engine.

17. Install a dial indicator so that the contact point rests against the crankshaft flange and the indicator axis is parallel to the crankshaft axis (Fig. 45).

18. Zero the dial indicator. Push the crankshaft forward and note the reading on the dial.

19. If the end play exceeds specifications, replace the thrust bearing. If the end play is less than the minimum limit, inspect the thrust bearing faces for scratches, burrs, nicks, or dirt. If the thrust faces are not damaged or dirty, they probably were not aligned properly. Install the thrust bearing and align the faces following the recommended procedure (steps 12, 13, 14, and 15). Check the end play which should be within specifications.

20. Install new bearing inserts in the connecting rods and caps. Check the clearance of each bearing following the procedure under Connect-

ing Rod Bearings.

21. If the bearing clearances are to specifications, apply a light coat of engine oil to the journals and bearings.

22. Turn the crankshaft throw to the bottom of the stroke. Push the piston all the way down until the rod bearing seats on the crankshaft journal.

23. Install the connecting rod cap. Torque the nuts to specifications.

24. After the piston and connecting rod assemblies have been installed, check the connecting rod side clearance on each connecting rod crankshaft journal.

25. Turn the engine on the work stand so that the front end is up. Install the timing chain and sprockets, cylinder front cover and crankshaft pulley or damper, as detailed under Cylinder Front Cover and Timing Chain Installation.

26. Clean the oil pan, oil pump, and oil pump screen.

27. Prime the oil pump by filling the inlet opening with oil and rotating the pump shaft until oil emerges from the outlet opening. Install the oil pump following steps 1, 2, and 3 under Oil Pump Installation. Install the oil pan following steps 2 thru 5 under Oil Pan Installation.

28 Position the flywheel on the crankshaft. Apply oil-resistant sealer to the flywheel attaching bolts. Install and torque the bolts to specifications.

On a flywheel for a manual-shift transmission, locate the clutch disc and install the pressure plate.

29. Turn the engine on the work stand so that the engine is in the normal position. Install the oil level dipstick. Install the accessory drive pulley (if so equipped). Install and adjust the drive belt and accessory belts to specifications.

30. Remove the engine from the work stand and install it in the vehicle.

## CAMSHAFT BEARING

The camshaft bearings are available pre-finished to size and require no reaming for standard and 0.015-inch undersize journal diameters.

### REMOVAL

1. Remove the flywheel and the camshaft. Remove the rear bearing bore plug.

2. Remove the camshaft bearings with the tool shown in Fig. 46.

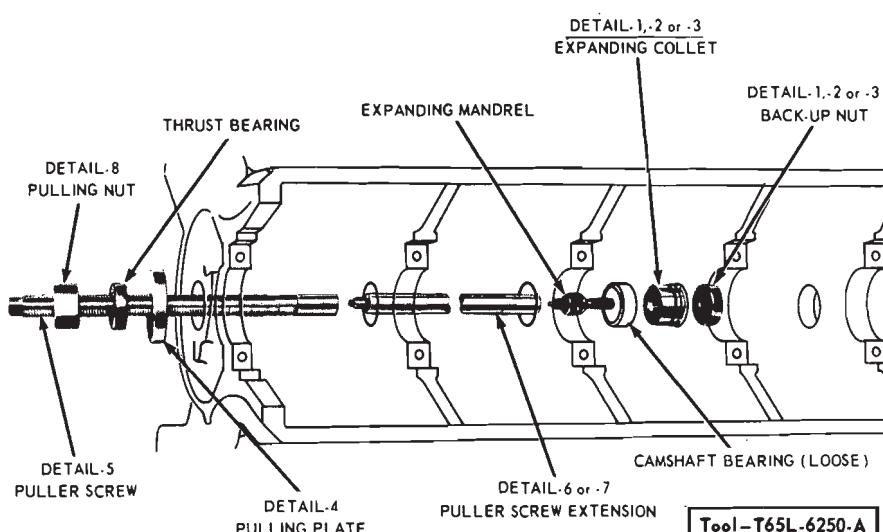
3. Select the proper size expanding collet and back-up nut and assemble on the expanding mandrel. With the expanding collet collapsed, install the collet assembly in the camshaft bearing, and tighten the back-up nut on the expanding mandrel until the collet fits the camshaft bearing.

4. Assemble the puller screw and extension (if necessary) as shown and install on the expanding mandrel. Wrap a cloth around the threads of the puller screw to protect the front bearing or journal. Tighten the pulling nut against the thrust bearing and pulling plate to remove the camshaft bearing. Be sure to hold a wrench on the end of the puller screw to prevent it from turning.

5. Repeat the procedure for each bearing. To remove the front bearing, install the puller screw from the rear of the cylinder block.

### INSTALLATION

6. Position the new bearings at the bearing bores, and press them in place with the tool shown in Fig. 47. Be sure to center the pulling plate and puller screw to avoid damage to the bearing. Failure to use the correct expanding collet can cause severe bearing damage. Align the oil holes in the bearings with the oil holes in the



**FIG. 46—Typical Camshaft Bearing Replacement**

cylinder block when the bearings are installed. Be sure the front bearing is installed below the front face of the cylinder block to specifications. The rear has two oil holes and must be installed 24 3/4 inches from the face of the camshaft thrust plate surface. Check the oil passage that feeds the rocker arm shaft for obstructions by squirting oil into the opening in the cylinder block and observing the flow through the oil hole at the rear camshaft bearing.

7. Install a new bearing bore plug as detailed in Part 21-01, In-Vehicle Adjustments and Repairs.

8. Install the camshaft, crankshaft, flywheel and related parts, following the appropriate procedures. Do not check connecting rod and main bearing clearances as a part of Camshaft Bearing Replacement. Install the engine in the vehicle.

## CYLINDER ASSEMBLY

### DISASSEMBLY

Follow steps 1 thru 3, 5 thru 13, and 24 under Engine Disassembly. Remove the cylinder assembly from the work stand.

### ASSEMBLY

Install the replacement cylinder block assembly on a work stand. Transfer all parts removed from the old cylinder assembly to the new cyl-

inder assembly, following the procedures under Engine Assembly. Check all assembly clearances.

## CYLINDER BLOCK

Before replacing any cylinder block refer to Part 21-01, Cleaning and Inspection, to determine whether it is repairable. If repairable, follow the given procedures.

## DISASSEMBLY

Follow the procedures under Engine Disassembly. Remove the cylinder assembly from the work stand.

Clean the gasket and seal surfaces of all parts and assemblies.

## ASSEMBLY

Install the replacement cylinder block assembly on a work stand. Transfer all parts removed from the old cylinder assembly, following the procedures under Engine Assembly. Check all assembly clearances.

## ENGINE DISASSEMBLY

1. Disconnect the distributor vacuum line at the carburetor.

2. Disconnect the carburetor fuel inlet line at the fuel filter, and at the fuel pump. Remove the fuel inlet line. Disconnect the distributor vacuum hose at the distributor.

3. Remove the crankcase ventila-

tion system by following the procedures under Positive Closed-Type Crankcase Ventilation System Removal in In-Vehicle Adjustments and Repairs.

4. Remove the automatic choke heat tube; then remove the carburetor and gasket. Remove the exhaust manifold.

5. Remove the coil. Remove the distributor cap and spark plug wires as an assembly. Remove the distributor, fuel pump, oil pressure sending unit, oil filter and oil filter mounting insert. Remove the spark plugs. Remove the distributor vacuum advance control valve (deceleration valve).

6. Remove the valve rocker arm cover. Remove the valve rocker arm shaft assembly (Fig. 11) by removing the support bolts evenly and equally two turns at a time.

7. Remove the valve push rods in sequence and identify them so that they can be installed in the original positions (Fig. 12).

8. Remove all cylinder head bolts. Lift the cylinder head assembly off the engine. Do not pry between the head and block as the gasket surfaces may become damaged. Using a magnet, remove the valve lifters and keep them in order so they can be installed in the original location (Fig. 27). If the valve lifters are stuck in the bores by excessive varnish, etc., it may be necessary to use a claw-type tool to remove the lifters.

On a flywheel for a manual-shift transmission, mark the pressure plate cover so that it can be replaced in the same position. Remove the clutch pressure plate and cover assembly.

Remove the flywheel. Remove the clutch pilot bushing (Fig. 36) and engine rear cover plate.

9. Remove the dipstick and the oil pan. Discard the gasket and seals.

10. Remove the oil pump and inlet tube assembly. Discard the oil pump gasket.

11. Loosen the alternator mounting bolts and disconnect the alternator adjusting arm at the water pump.

12. Remove the alternator, the water pump and the accessory drive pulley (if so equipped). Remove the crankshaft damper. Remove the damper by using tool T58P-6316-B.

13. Remove the cylinder front cover. Discard the gasket. Check the camshaft end play by following step 15 under Camshaft Removal. Check timing chain deflection as detailed under Cylinder Front Cover Removal.

14. Remove the camshaft sprocket attaching bolt and washer. Slide both

sprockets and the timing chain forward and remove them as an assembly (Fig. 21).

15. Remove any ridges and/or deposits from the upper end of the cylinder bores. Remove the cylinder ridges with a ridge cutter. Follow the instructions furnished by the tool manufacturer. Never cut into the ring travel area in excess of 1/32 inch when removing ridges.

16. Make sure all bearing caps (main and connecting rod) are marked so they can be installed in the original locations. Turn the crankshaft until the connecting rod being removed is down. Remove the connecting rod cap.

17. Push the connecting rod and piston assembly out the top of the cylinder with the handle end of a hammer. Avoid damage to the crankpin or the cylinder wall when removing the piston and rod.

18. Remove the bearing inserts from the connecting rods and caps. Remove the main bearing caps.

19. Carefully lift the crankshaft out of the cylinder block so that the thrust bearing surfaces are not damaged. Handle the crankshaft with care to avoid possible fracture or damage to the finished surfaces.

20. Remove the rear journal oil seal from the block and rear main bearing cap. Remove the main bearing inserts from the block and bearing caps.

21. Remove the camshaft thrust plate. Carefully remove the camshaft by pulling it toward the front of the engine. Use caution to avoid damaging the journals and lobes.

22. Remove the camshaft rear bearing bore plug.

23. Remove the camshaft bearings (Fig. 47).

24. Remove the dipstick tube and the plug or drain.

## ENGINE ASSEMBLY

Clean and inspect all parts per the appropriate procedures in Part 21-01, Cleaning and Inspection, except do not disassemble the oil pump and hydraulic valve lifters for cleaning.

1. Install the camshaft bearings and rear bore plug by following steps 6 and 7 under Camshaft Bearing Replacement.

2. The camshaft and related parts are shown in Fig. 26. Oil the camshaft journals and apply Lubriplate to all camshaft lobes. Carefully slide the camshaft through the bearings.

3. Install the thrust plate. Torque

the attaching screws to specifications.

4. The crankshaft and related parts are shown in Fig. 43. Be sure that the rear journal oil seal grooves are clean. Install a new rear journal oil seal in the block and rear main bearing cap. After installation, cut the ends of the seals flush.

5. If the crankshaft main bearing journals have been refinished to a definite undersize, install the correct undersize bearings. Be sure the bearing bores are clean. Place the upper main bearing inserts in position in the bore with the tang fitting in the slot provided.

6. Install the lower main bearing inserts in the bearing caps.

7. Carefully lower the crankshaft into place. Be careful not to damage the bearing surfaces.

8. Select fit the bearings for proper clearance following procedures under Fitting Main and Connecting Rod Bearings in Part 21-01.

9. After the bearings have been fitted, apply a light coat of engine oil to the journals and bearings. Install all the bearing caps, except the thrust bearing cap. Be sure that the main bearing caps are installed in the original locations. Torque the bearing cap bolts to specifications.

10. Install the thrust bearing cap by following steps 12 thru 15 under Crankshaft Installation.

11. Check the crankshaft end play by following steps 17 thru 19 under Crankshaft Installation.

12. Turn the engine on the work stand so that the front end is up.

13. Oil the piston rings, pistons, and cylinder walls with light engine oil.

14. Be sure to install the pistons in the same cylinders from which they were removed, or to which they were fitted. The connecting rods and bearing caps are numbered from 1 to 6 beginning at the front of the engine. The numbers on the connecting rod and bearing cap must be on the same size when installed in the cylinder bore. If a connecting rod is ever transferred from one block or cylinder to another, new bearings should be fitted and the connecting rod should be numbered to correspond with the new cylinder number.

15. Make sure the ring gaps are properly spaced around the circumferences of the piston.

16. Install a piston ring compressor on the piston and push the piston in with a hammer handle until it is slightly below the top of the cylinder. Be sure to guide the connecting rods

to avoid damaging the crankshaft journals. Install the piston with the notch in the piston head toward the front of the engine (Fig. 35).

17. Check the clearance of each bearing following the procedure under Connecting Rod Bearing Replacement.

18. After the bearings have been fitted, apply a light coat of engine oil to the journals and bearings.

19. Turn the crankshaft throw to the bottom of its stroke. Push the piston all the way down until the connecting rod bearing seats on the crankshaft journal.

20. Install the connecting rod cap. Torque the nuts to specifications.

21. After the piston and connecting rod assemblies have been installed, check the connecting rod side clearance on each crankshaft journal (Fig. 32).

22. Lubricate the timing chain and sprockets with engine oil. Place the keys in position in the slots on the crankshaft and camshaft.

23. Position the sprockets and timing chain on the camshaft and crankshaft. Be sure the timing marks on the sprockets and chain are positioned as shown in Fig. 21.

24. Install the camshaft sprocket attaching bolt and washer. Torque the bolt to specifications. Check the camshaft end-play (Fig. 28).

25. Clean the cylinder front cover and the gasket surface of the cylinder block.

26. Install a new crankshaft front oil seal.

27. Coat the gasket surface of the block and the cover with oil-resistant sealer. Position a new gasket on the block.

28. Using tool T61K-6019-A, Install the cylinder front cover on the block. Torque the screws to specifications. Apply Lubriplate to the seal surface, and to the seal running surface, of the damper.

29. Line up the crankshaft damper keyway with the key on the crankshaft.

30. Install the crankshaft damper using tool T52L-6306-AEE. Torque the attaching bolt to specifications. Install the accessory drive pulley if so equipped.

31. Install the water pump, alternator, fan pulley, and fan. Install and adjust all belts to specifications.

32. Prime the oil pump by filling either the inlet or outlet port with engine oil. Rotate the pump shaft to distribute the oil within the pump body.

**33.** Using a new gasket, install the oil pump. Clean and install the oil inlet tube assembly.

**34.** Make sure the gasket surfaces of the block and oil pan are clean.

**35.** Coat the block surface and oil pan gasket surface with oil-resistant sealer and position the gasket on the block (Fig. 39).

**36.** Install the oil pan front seal on the cylinder front cover and the oil pan rear seal on the rear main bearing cap. **Be sure the tabs on the seals are over the oil pan gasket.**

**37.** Position the oil pan on the block. Install the attaching screws. Torque the screws from the center outward in each direction to specifications.

**38.** Turn the engine on the work stand so that the top of the engine is up. Install the clutch pilot bushing (Fig. 39). Install the engine rear cover plate, position the flywheel on the crankshaft. Apply oil-resistant sealer to the flywheel bolts and install the attaching bolts. Torque the bolts to specifications.

On a flywheel for a manual-shift transmission, use Tool 7563 to locate the clutch disc. Install the pressure plate. Torque the attaching bolts to specifications.

**39.** Using a new gasket, install the fuel pump.

**40.** Turn the crankshaft until No. 1 cylinder is at TDC after the compression stroke. Position the distributor and intermediate drive shaft into the block with the rotor at the No. 1 firing position and the breaker points open. Install the hold down clamp. **Make sure the oil pump intermediate drive shaft is properly seated in the oil pump. It may be necessary to reposition the intermediate shaft to engage it in the oil pump.**

**41.** Install the oil filter insert and oil filter assembly.

**42.** Dip the valve lifter foot in Lubriplate. Coat the remainder of each valve lifter with engine oil. Install the

lifters in the original bores.

**43.** Clean the head and block gasket surfaces.

**44.** Inspect the head for any damage and repair as necessary.

**45.** On a 170 or 250 CID engine, apply cylinder head gasket sealer to both sides of a new gasket. **Do not apply sealer to the gasket on a 200 six engine.** Composition head gaskets are to be installed without sealer. Install the cylinder head guide studs (Fig. 14). Position the gasket over the guide studs on the cylinder block.

**46.** Lift the cylinder head over the guides and slide it down carefully. Before installing the cylinder head bolts, coat the threads of the end bolts for the right side of the cylinder head with a small amount of water resistant sealer. Install, but do not tighten, two bolts at opposite ends of the head to hold the head and gasket in position. Remove the guides, then install the remaining bolts.

**47.** The cylinder head bolts are torqued in three progressive steps. Follow the sequence shown in Fig. 15. Torque the bolts to 55 ft-lbs; then torque them to 65 ft-lbs. Finally, torque the bolts to specifications. When cylinder head bolts have been tightened following this procedure, it is not necessary to retorque the bolts after extended operation. However, on cylinder heads with composition gaskets, the bolts may be checked and retorqued, if desired.

**48.** Apply Lubriplate to both ends of the push rods. Install the push rods in their proper sequence, positioning the lower end of the rods in the lifter sockets.

**49.** Apply Lubriplate to the valve tips and the rocker arm pads. Position the valve rocker arm shaft assembly on the head. **Be sure the oil holes in the shaft are facing downward.**

**50.** Install the valve rocker arm shaft bolts. Tighten them in sequence

two turns at a time until the specified torque is obtained.

**51.** Check the valve clearance.

**52.** Clean the gasket surfaces on the valve rocker arm cover and cylinder head. Coat one side of a new gasket with an oil-resistant sealer and lay the cemented side of the gasket on the cover. Install the cover making sure the gasket seats evenly around the head. Torque the cover bolts to specifications. Torque the cover bolts to specifications again two minutes later.

**53.** Install the spark plugs. Install the distributor cap and spark plug wire assembly. Connect the spark plug wires. Install the coil on the block and connect the coil high tension lead. Install the distributor vacuum advance control valve (deceleration valve).

**54.** Position the exhaust manifold on the cylinder head. Install the tab washers and bolts. Torque the bolts to specifications. Lock the bolts by bending one tab of the washer over a flat on the bolt.

**55.** Position the carburetor gasket on the manifold. Install the carburetor.

**56.** Install the carburetor fuel inlet line, the manifold vacuum line and the distributor vacuum hoses, and the automatic choke heat tube.

**57.** Install the crankcase ventilation system by following the procedure under Positive Closed-Type Crankcase Ventilation System Installation. Install the air and vacuum hoses brackets. Connect all vacuum lines using previous identification for proper connections.

**58.** Install the oil pressure sending unit, dipstick tube and dipstick.

**59.** Install the engine in the vehicle.

**60.** Check the ignition timing and adjust if necessary. Connect the distributor vacuum line. Adjust the engine idle fuel mixture and idle speed.

## 5 SPECIFICATIONS

### GENERAL SPECIFICATIONS

Engine	Compression Ratio	Bore and Stroke	Taxable Horsepower	Brake Horsepower	Gross Torque Ft.-Lbs.
170	9.1:1	3.50 x 2.94	29.4	105 @ 4400	158 @ 2400
200	8.1:1	3.68 x 3.13	32.5	120 @ 4400	190 @ 2400
250	9.1:1	3.68 x 3.91	32.5	155 @ 4400	240 @ 1800

### GENERAL SPECIFICATIONS (Continued)

Engine	Compression Pressure PSI (Sea Level) @ Cranking Speed ①	Engine Idle Manifold Vacuum ②	Oil Pressure-Hot @ 2000 RPM	Firing Order	Belt Tension (Ft. Lbs.) ③
170					
200					
250	When checking compression, take the highest compression reading and compare it to the lowest reading. The lowest reading must be within 75% of the highest.	17	35-60	1-5-3- 6-2-4	New Used 140 110

① See Compression Pressure Limit Chart in Part 21-01.  
 ② Minimum inches of Mercury @ specified engine RPM (sea level). This includes automatic transmission in neutral. Subtract 1 inch of Mercury for engines equipped with dual diaphragm distributors.  
 ③ All belts.

### ENGINE PERFORMANCE SPECIFICATIONS

Engine	Curb Idle RPM ①	Fast Idle RPM ②	Initial Ignition Timing ③
170	Standard Transmission 750 (non A/C)-800 (A/C) Automatic Transmission 550 (non A/C) 600 (A/C)	Standard Transmission 0.036 Automatic Transmission 0.035	6°
200	Standard Transmission 750 (non A/C) 600 (A/C) Automatic Transmission 550 (non A/C) 600 (A/C)	Standard Transmission 0.031 Automatic Transmission 0.036	6°
250	Standard Transmission 750/500 ④ Automatic Transmission 600/500 ④	Standard Transmission 0.040 Automatic Transmission 0.046	6°

① Headlamps on Hi Beam—Air conditioning OFF

② Higher idle speed with solenoid energized and lower idle speed with solenoid de-energized.

③ Throttle Plate Clearance—See Part 21-01

④ Distributor vacuum line disconnected

### ENGINE PERFORMANCE SPECIFICATIONS (Continued)

Engine	Dwell Angle At Idle Speed	Distributor Point Gap	Spark Plug Gap	Spark Plug No. ①
170, 200	35-40	0.027	0.032-0.036	BF-82
250	37-42	0.025		

① Installation torque 15-20 Ft.-Lbs.

### ENGINE PERFORMANCE SPECIFICATIONS (Continued)

ENGINE	Anti-Stall Dashpot Clearance	Automatic Choke Setting	ACCELERATOR PUMP SETTING				IDLE AIR-FUEL RATIO	
			Pump Stroke	Lever Position	Manual	Automatic		
170-1V	7/64	1-Rich	Manual	Automatic	Manual	Automatic	Manual	Automatic
200-1V		Index					14.45	14.45
250-1V	Solenoid Equipped	7/32	Index	1-Rich	0.400	0.400	14.20	14.20
							14.45	14.20

**CYLINDER HEAD**

Engine	Combustion Chamber Volume	Valve Guide Bore Diameter (Standard Intake and Exhaust)	Valve Seat Width		Valve Seat Angle	Valve Seat Runout (Maximum)	Valve Arrangement (Front to Rear)	Rocker Arm Stud Bore Dia. Std.	Gasket Surface Flatness ①
			Intake	Exhaust					
170-200	51.5-54.0	0.3115-0.3125	0.060-0.080	0.070-0.090	Intake and Exhaust 45°	0.0015	E-I-I-E-I-E E-I-E-I-I-E		0.003 in any 6 inches 0.007 overall
250	59.4-62.4								

① Head Gasket Surface Finish R.M.S. 90-150.

**VALVE ROCKER ARMS, ROCKER ARM SHAFT, PUSHRODS AND TAPPETS**

Engine	Rocker Arm Shaft O.D.	Rocker Arm To Rocker Shaft Clearance ①	Rocker Arm Bore Diameter	Rocker Arm Lift Ratio	Valve Push Rod (Maximum Runout)	VALVE TAPPET OR LIFTER		
						Standard Diameter	Clearance To Bore ②	Hydraulic Lifter Leakdown Rate
170-200								
250	0.780-0.781	0.002-0.004	0.783-0.784	1.50:1	0.025	0.8740-0.8745	0.0007-0.0027	5.50 Seconds Maximum—Measured at 1/16 inch plunger travel

① Wear Limit 0.0060

② Wear Limit -0.005

**VALVE SPRINGS**

Engine	Valve Spring Pressure Lbs @ Specified Length			Valve Spring Free Length Approximate	Valve Spring Assembled Height Pad to Retainer	Valve Spring Out-of-Square (Maximum)
	Pressure	Wear Limit				
170-200-250	51-57 @ 1.590 142-158 @ 1.222	46 @ 1.590 128 @ 1.222		1.79	1 9/16-1 5/8	5/64 (.078)

**VALVES**

Engine	Valve Stem To Valve Guide Clearance		Valve Stem to Rocker Arm Clearance Hydraulic Lifters ①		Valve Head Diameter		Valve Face Angle ②	Minimum Allowable Valve Stem Tip Length
	Intake	Exhaust	Allowable	Desired	Intake	Exhaust		
170	0.0008-0.0025 ①	0.0010-0.0027	0.066-0.166	0.066-0.117	1.642-1.657	1.381-1.396	Intake and Exhaust 44°	
200			0.095-0.195	0.095-0.145				
250			0.095-0.195		1.642-1.657	1.381-1.396		

① Wear Limit 0.0055

② Valve face runout ..... Maximum 0.0020

## VALVES (Continued)

Engine	Valve Stem Diameter							
	Standard		0.003 Oversize		0.015 Oversize		0.030 Oversize	
	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust
170	0.3100- 0.3107	0.3098- 0.3105	0.3130- 0.3137	0.3128- 0.3135	0.3250- 0.3257	0.3248- 0.3255	0.3400- 0.3407	0.3398- 0.3405
200								
250								

## CAMSHAFT

Engine	Lobe Lift <sup>①</sup>		Theoretical Valve Lift		Camshaft		Camshaft Journal to Bearing Clearance	
	Intake	Exhaust	Intake	Exhaust	End Play	Wear Limit	Clearance	Wear Limit
170	0.2320	0.2320	0.3480	0.3480	0.001-0.007	0.009	0.001-0.003	0.006
200								
250	0.245	0.245	0.368	0.368	0.001-0.007			

①Maximum allowable lobe lift loss ..... 0.005

## CAMSHAFT (Continued)

Item	Bearing	170, 200, 250	CAMSHAFT VALVE TIMING EVENTS					
			Item	170, 200	250			
Camshaft Journal Diameter Standard <sup>②</sup>	(No. 1)	1.8095-1.8105	Intake Valve Opens (BTDC)	0.002 @ 9°	0.003 @ 10°			
	(No. 2)		Intake Valve Closes (ABDC)	0.005 @ 51°	0.004 @ 62°			
	(No. 3)		Exhaust Valve Opens (BBDC)	0.002 @ 42°	0.003 @ 49°			
	(No. 4)							
	(No. 5)							
Camshaft Bearings Inside Diameter	(No. 1)	1.8115-1.8125						
	(No. 2)							
	(No. 3)							
	(No. 4)							
	(No. 5)							
Camshaft Bearing Location <sup>③</sup>	(No. 1)	0.1150-0.1250	Exhaust Valve Closes (ATDC)	0.005 @ 18°	0.004 @ 25°			

①Camshaft journal maximum runout 0.005

Camshaft journal maximum out-of-round 0.005

②Distance in inches that the front edge of the bearing is installed towards the rear from the front face of the cylinder block.

## CAMSHAFT DRIVE MECHANISM

Engine	Camshaft Gear To Crankshaft Gear Backlash	CAMSHAFT GEAR OR SPROCKET	CRANKSHAFT GEAR OR SPROCKET	Timing Chain Deflection (Maximum)
		Assembled Face Runout T.I.R. Max.	Assembled Face Runout T.I.R. Max.	
170, 200				
250			0.006	0.500

**CYLINDER BLOCK**

Engine	Cylinder Bore Diameter①	Cylinder Bore Diameter 0.003 O.S.	Tappet Bore Diameter	Main Bearing Bore Diameter	Cylinder Block Distributor Shaft Bearing Bore Diameter	Head Gasket Surface Flatness②	Crankshaft To Rear Face Of Block Runout T.I.R. Max.
170	3.5000-3.5024	3.5024-3.5036				0.003 inch in any 6 inches or 0.007 inch Overall	
200	3.6800-3.6824	3.6824-3.6836	0.8752-0.8767	2.4012-2.4020	0.4525-0.4535		0.010
250				2.5902-2.5910			
①Maximum out-of-round ..... 0.001 Wear Limit ..... 0.005 Cylinder bore surface finish RMS ..... 15-35 Maximum Taper ..... 0.001 Wear Limit ..... 0.010	②Head gasket surface finish RMS ..... 90-150						

**CRANK SHAFT AND FLYWHEEL**

Engine	Main Bearing Journal Diameter①	Main Bearing Journal Runout-Maximum	Main Bearing Journal Thrust Face Runout	Main Bearing Journal Taper Max.	Thrust Bearing Journal Length	Main Bearing Surface Finish R.M.S. Maximum	
						Journal	Thrust Face
170, 200	2.2482-2.2490				1.275-1.277		20 Front
250	2.3982-2.3990	0.005	0.001	0.003 Per Inch	1.199-1.201	12	20 Rear
①Connecting rod and main bearing journal out-of-round maximum 0.0004							

**CRANK SHAFT AND FLYWHEEL (Continued)**

Engine	Connecting Rod Journal Diameter①	Connecting Rod Bearing Journal Maximum Taper	Crankshaft Free End Play	Flywheel Clutch Face Runout	Flywheel O.D. Runout Transmission	
					Standard	Automatic
170, 200	2.1232-2.1240			0.007		
250		0.003 Per Inch	0.004-0.008 ②	0.010	0.018	0.020
①Connecting rod and main bearing journal out-of-round maximum 0.0004 (all engines)						
②Wear Limit 0.012						

**CRANKSHAFT BEARINGS**

Engine	Connecting Rod Bearings			Main Bearings		
	To Crankshaft Clearance		Wall Thickness Standard①	To Crankshaft Clearance		Wall Thickness Standard②
	Desired	Allowable		Desired	Allowable	
170, 200		0.0008-0.0024	0.0571-0.0574			0.0758-0.0761
250	0.001-0.0015			0.0005-0.0015	0.0005-0.0022	0.0954-0.0957
①0.002 U.S. Thickness Add 0.0583-0.0588 to Standard Thickness						
②0.002 U.S. Thickness Add 0.0010 to Standard Thickness						

**CONNECTING ROD**

Engine	Piston Pin Bore Or Bushing I.D.	Connecting Rod Bearing Bore Diameter ①	Connecting Rod Length Center To Center	Connecting Rod Alignment Maximum Total Difference②		Connecting Rod Assembly (Assembled To Crankshaft)	
				Twist	Bend	Side Clearance	Wear Limit
170, 200	0.9107-0.9112	2.2390-2.2398	4.7135-4.7165	0.008		0.0035-0.0105	0.014
250			5.8185-5.8815		0.004		
①Connecting rod bearing bore maximum out-of-round and taper ..... 0.0004							
②Pin bushing and crankshaft bearing bore must be parallel and in the same vertical plane within the specified total difference at ends of 8-inch long bar measured 4 inches on each side of rod.							

21-02-27

## 170, 200 And 250!Six Engine

21-02-27

## PISTON

Engine	Diameter①			Piston To Cylinder Bore Clearance	Piston Pin Bore Diameter	Ring Groove Width
	Coded Red	Coded Blue	0.003 Oversize			
170	3.4982- 3.4987	3.4993- 3.4999	3.5001- 3.5005	0.0013-	0.9122- 0.9125	Upper Compression Ring ..... 0.080-0.081
200 250	3.6778- 3.6784	3.6790- 3.6796	3.6802- 3.6808			Lower Compression Ring ..... 0.080-0.081 Oil Ring ..... 0.1880-0.1890
Measured at the piston pin bore centerline at 90° to the pin bore.						

## PISTON PIN

Engine	Diameter				To Piston Clearance	To Connecting Rod Bushing Clearance
	Length	Standard	0.001 Oversize	0.002 Oversize		
170, 200	3.010-3.040	0.9119-0.9124	0.9130-0.9133	0.9140-0.9143	0.0003-0.0005	Interference Fit
250						
Wear Limit	0.0008					

## PISTON RINGS

Engine	Ring Width		Side Clearance		Ring Gap Width		Oil Ring②	
	Compression Ring		Compression Ring①		Oil Ring	Compression Ring		
	Top	Bottom	Top	Bottom		Top		
170, 200, 250	0.077-0.078	0.077-0.078	0.002- 0.004	0.002- 0.004	Snug	0.010-0.020	0.010-0.020	0.015-0.055
Wear Limit (All Engines) .....	0.006							
①Steel Rail								

## OIL PUMP

Engine	Rotor Type Oil Pump Relief Valve Spring Tension Lbs @ Specified Length	Drive Shaft To Housing Bearing Clearance	Relief Valve Clearance	Rotor Assembly End Clearance	Outer Race To Housing (Radial Clearance)
170, 200	9.0-10.1 @ 1.078				
250	20.6-22.6 @ 2.49	0.0015-0.0029	0.0015-0.0029	0.0011-0.0041	0.006-0.013

## APPROXIMATE OIL PAN CAPACITIES①

Engine	U.S. Measure	Imperial Measure
170, 200, 250	4 1/2 Quarts	3 1/2 Quarts
Includes one quart with filter replacement		

## TORQUE LIMITS-FT. LBS.

Engine	Cylinder Head Bolts			Oil Pan To Cylinder Block	Manifolds To Cylinder Head		Water Outlet Housing	Distributor Vacuum Control Valve	Flywheel To Crankshaft
	Step 1	Step 2	Step 3		Intake	Exhaust			
170, 200	55	65	70-75	7-9		13-18	12-15	15-18	75-85
250						13-18			

## TORQUE LIMITS-FT. LBS. (Continued)

Engine	Main Bearing Cap Bolts	Oil Pan Drain Plug	Oil Pump To Cylinder Block	Oil Pump Cover Plate	Oil Filter Adapter To Cylinder Block	Oil Filter To Adapter Or Cylinder Block	Cylinder Front Cover
170, 200	60-70	15-20	12-15	6-9	10-15	With grease on the gasket surface, hand-tighten until gasket contacts adapter face, then tighten 1/2 turn more.	7-9
250							

CA1038-A

**TORQUE LIMITS-FT. LBS. (Continued)**

Engine	Water Pump To Cylinder Block Or Front Cover	Camshaft Sprocket To Camshaft	Camshaft Thrust Plate In Block	Damper Or Pulley To Crankshaft	Connecting Rod Nuts	Valve Rocker Arm Cover
170						
200					19-24	3-5
250		12-15	35-45	12-15	85-100	21-26

**TORQUE LIMITS-FT. LBS. (Continued)**

Engine	Valve Rocker Shaft Support To Cylinder Head	Oil Inlet Tube To Oil Pump	Fuel Pump To Cylinder Block Or Cylinder Front Cover	Pulley To Damper Bolts
170				
200				
250	30-35	12-15	12-15	UBS Bolts 25-35 Place Bolts 35-45

**TORQUE LIMITS FOR VARIOUS SIZE BOLTS-FT. LBS.**

Caution: If any of the torque limits listed in this table disagree with any of those listed in the preceding tables, the limits listed in the preceding tables prevail.

Size (Inches)	1/4-20	1/4-28	5/16-18	5/16-24	3/8-16	3/8-24
Torque (Ft-lbs)	6-9	6-9	12-15	15-18	23-28	30-35
Size (Inches)	7/16-14	7/16-20	1/2-13	1/2-20	9/16-18	5/8-18
Torque (Ft-lbs)	45-50	50-60	60-70	70-80	85-95	130-145

**ENGINE SUPPORT TORQUE LIMITS-FT. LBS**

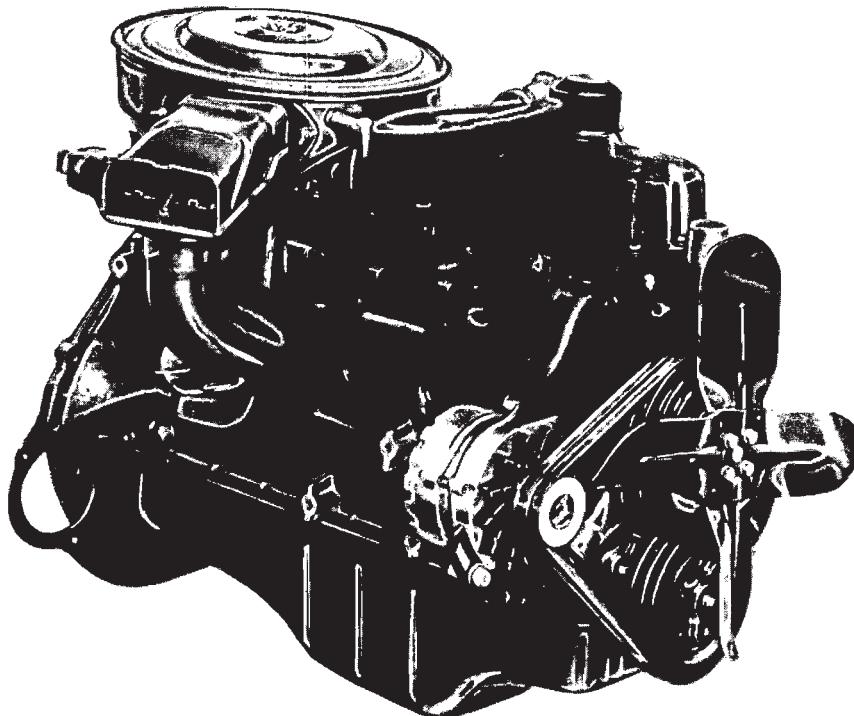
FRONT SUPPORTS	170	200	250
Insulator Bracket to Engine			15-23
Insulator Bracket to Insulator			20-30
Insulator to Support Bracket			30-50
Mounting Bracket to Frame			20-30
Insulator to Frame Bracket Through Bolt (Nut)			20-30
Crossmember to Frame (Mustang)			45-60
Rear Supports			
Insulator to Transmission— Manual	30-45		15-25
Automatic	30-45		30-45
Crossmember to Frame	14-24		10-20
Insulator to Crossmember— Maverick	30-50		
Mustang		25-35	
Fairlane and Montego		30-50	

# PART 21-03 240 CID Six Engine

## MODEL APPLICATION—FORD AND METEOR FORD AND METEOR POLICE AND TAXI

Component	Page	Component	Page
CAMSHAFT .....	03-11	OIL FILTER .....	03-17
Bearing Bore Plug .....	03-12	Installation .....	03-17
Bearing Removal and Installation .....	03-22	Removal .....	03-17
Camshaft Removal and Installation .....	03-11		
CLUTCH PILOT BUSHING .....	03-16	OIL PAN .....	03-17
Installation .....	03-16	Installation .....	03-18
Removal .....	03-16	Removal .....	03-17
CRANKSHAFT .....	03-21	OIL PUMP .....	03-18
Installation .....	03-22	Assembly .....	03-18
Removal .....	03-21	Disassembly .....	03-18
Rear Oil Seal .....	03-16	Installation .....	03-18
CYLINDER ASSEMBLY (SHORT BLOCK) .....	03-23	Removal .....	03-17
Assembly .....	03-23		
Disassembly .....	03-23	PISTONS AND CONNECTING RODS .....	03-14
CYLINDER BLOCK .....	03-23	Assembly .....	03-15
Assembly .....	03-23	Disassembly .....	03-15
Disassembly .....	03-23	Installation .....	03-14
CYLINDER FRONT COVER .....	03-09	Removal .....	03-14
Installation .....	03-10		
Oil Seal .....	03-10	SPECIFICATIONS .....	03-26
Removal .....	03-09		
CYLINDER HEAD .....	03-06	TIMING GEARS .....	03-10
Assembly .....	03-08	Installation .....	03-11
Disassembly .....	03-08	Removal .....	03-10
Installation .....	03-07		
Removal .....	03-06	VALVE CLEARANCE ADJUSTMENT .....	03-05
ENGINE .....	03-24		
Assembly .....	03-02	VALVE LIFTERS .....	03-13
Description .....	03-23	Assembly .....	03-13
Disassembly .....	03-18	Disassembly .....	03-13
Removal and Installation .....	03-03	Installation .....	03-13
Supports—Front .....	03-03	Removal .....	03-13
Supports—Rear .....	03-03		
EXHAUST EMISSION CONTROL SYSTEM		VALVE ROCKER ARM ASSEMBLY .....	03-06
DESCRIPTION .....	03-02	Installation .....	03-06
FLYWHEEL .....	03-16	Removal .....	03-06
Installation .....	03-16		
Removal .....	03-16	VALVE ROCKER ARM COVER .....	03-05
MAIN AND CONNECTING ROD BEARINGS		Installation .....	03-05
Connecting Rod Bearings .....	03-14	Removal .....	03-05
Main Bearings .....	03-14		
MANIFOLDS—INTAKE AND EXHAUST .....	03-03	VALVE SPRING, RETAINER AND STEM	03-08
Installation .....	03-04	SEAL .....	03-08
Removal .....	03-03	Installation .....	03-09
		Removal .....	03-08
		VENTILATION SYSTEM—CRANKCASE .....	03-04
		Installation .....	03-04
		Removal .....	03-04
		WATER PUMP .....	03-09
		Installation .....	03-09
		Removal .....	03-09

## 1 DESCRIPTION



A 3210-A

FIG. 1—Right Front View—240 CID Six

### ENGINE

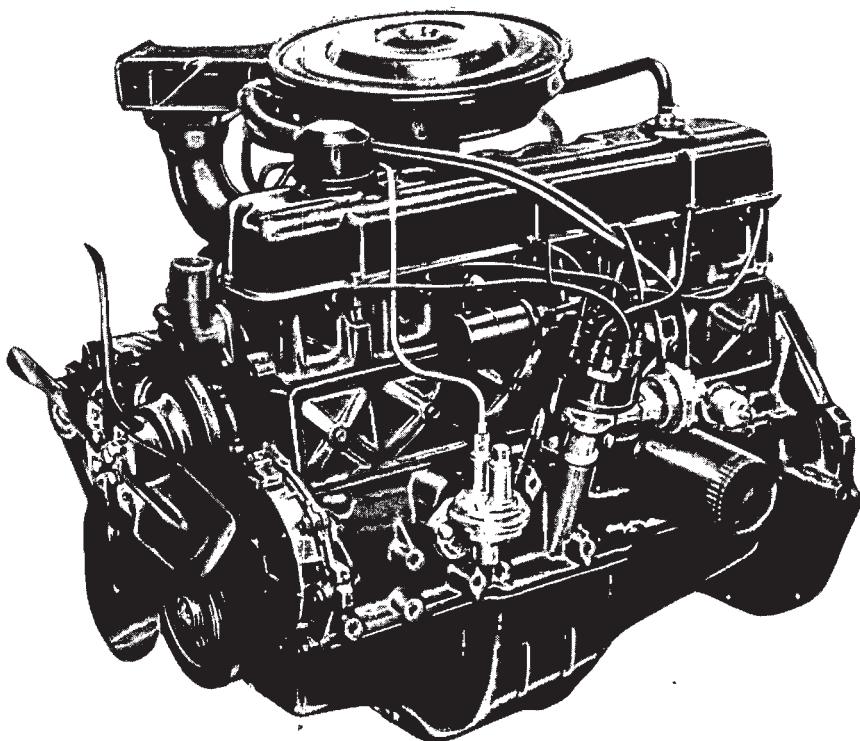
The 240 Six engine (Figs. 1, 2 and 3) warranty plate identification symbols are as follows: 240 Six-Symbol V; Police Special Six-Symbol B and Taxi Special Six-Symbol E.

An engine identification tag is attached to the engine under one of the coil mounting bolts; refer to Part 21-01.

### EXHAUST EMISSION CONTROL SYSTEM

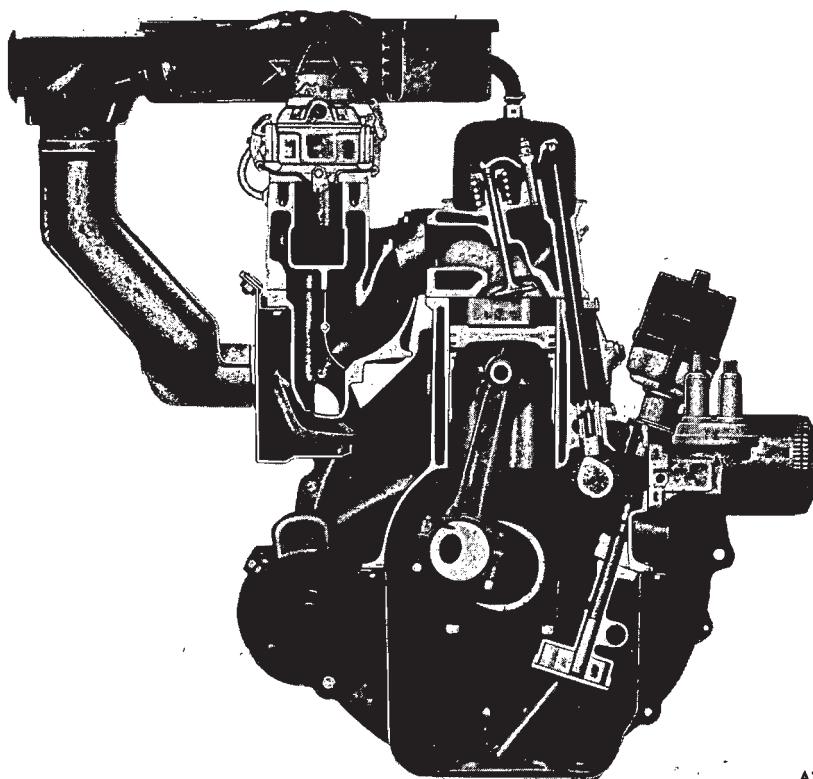
The 240 engine uses the Imco exhaust emission control system to keep exhaust gas contaminants at an acceptable level.

A positive closed-type crankcase ventilation system reduces the amount of air pollutants emitted by the crankcase ventilating system.



A2712-A

FIG. 2—Left Front View—240 CID Six



A2713-A

FIG. 3—Front Cross Section View—240 CID Six

## 2 IN-VEHICLE ADJUSTMENTS AND REPAIRS

When installing nuts or bolts that must be torqued (refer to the end of this Part for torque specifications), oil the threads with light-weight engine oil. **Do not oil threads that require oil-resistant or water-resistant sealer.**

Refer to Part 21-01, Section 3 for cleaning and inspection procedures.

Refer to Part 21-01, Section 1 for test procedures.

### ENGINE SUPPORTS

#### FRONT SUPPORT INSULATOR

##### Removal

- Raise the hood. Then raise the vehicle with a hoist.
- Loosen the nuts attaching the insulator assemblies to the intermediate support brackets (Fig. 4).
- Position a transmission jack under the oil pan and raise the engine sufficiently to remove its weight from the supports.

- Remove the insulator assembly(ies) to engine bolts and lock washers. Remove the insulator to intermediate support bracket nut(s). Remove the insulator(s).

##### Installation

- Install the insulator assembly(ies) on the intermediate support bracket(s). Install the nut, but do not tighten it.

- Position the insulator(s) and install the bolts and lock washers securing the insulator assembly(ies) to the engine. Torque the bolts to specifications.

- Lower the engine and remove the jack. Torque the insulator to intermediate support bracket nut(s) to specifications.

#### REAR SUPPORT INSULATOR

##### Removal

- Remove the insulator assembly

to crossmember attaching bolt and nut.

- Raise the transmission with a jack to obtain clearance at the transmission extension housing. Then remove the retainer and insulator assembly attaching bolts and washers. Remove the insulator assembly and the retainer.

##### Installation

- Position the insulator assembly and retainer; then install the attaching bolts and lock washers. Torque the bolts to specifications.

- Lower the transmission. Install the insulator assembly to cross member attaching bolt and nut. Torque the nut to specifications.

### INTAKE AND EXHAUST MANIFOLDS

#### REMOVAL

- Remove the air cleaner. Remove

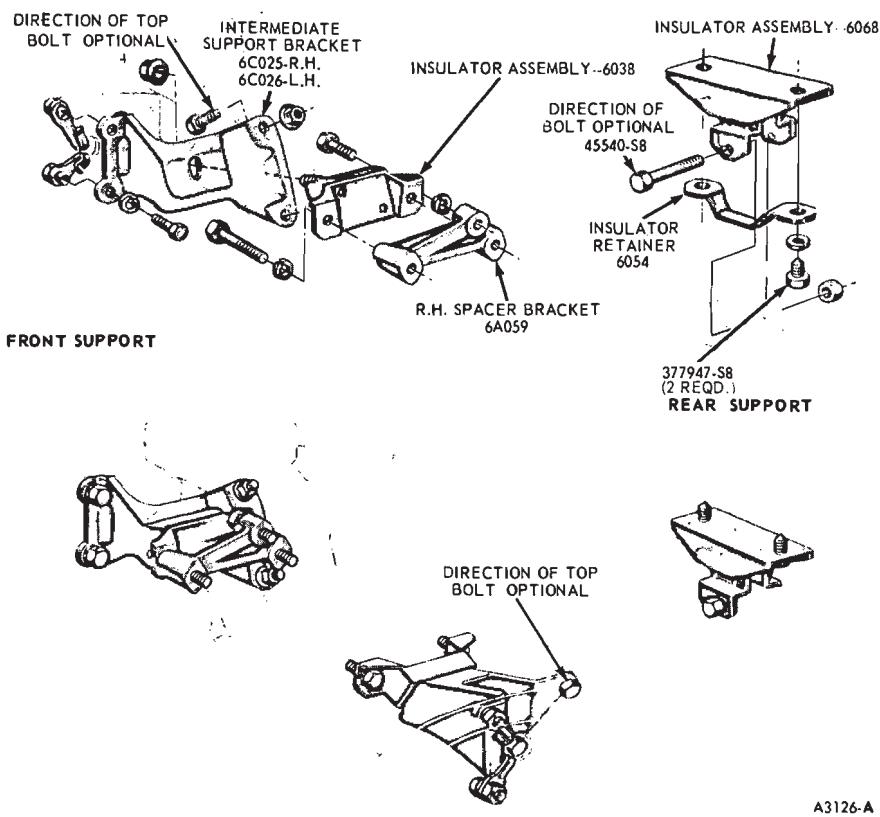


FIG. 4—Engine Supports

the accelerator retracting spring and disconnect the accelerator cable from the carburetor. Remove the accelerator cable bracket from the cylinder head and position the cable assembly out of the way.

On a vehicle with an automatic transmission, remove the kickdown rod retracting spring. Remove the bellcrank assembly from the engine.

2. Disconnect the distributor vacuum advance control valve (deceleration valve) vacuum hoses at the carburetor and at the intake manifold.

3. Remove the alternator mounting bolts and position the alternator out of the way, leaving the wires connected.

4. Remove the crankcase vent hose from the inlet tube in the intake manifold.

5. Disconnect the fuel inlet line and the distributor vacuum line from the carburetor.

Disconnect the power brake vacuum line, if so equipped.

6. Disconnect the muffler inlet pipe from the exhaust manifold.

7. Remove the bolts and nuts fastening the manifolds to the cylinder head. Lift the manifold assemblies from the head. Remove the gaskets.

8. To separate the manifolds, remove the carburetor. Remove the

nuts joining the intake and exhaust manifolds. Discard the gasket between the manifolds.

#### INSTALLATION

If the exhaust gas control valve requires replacement, install a new valve, following the procedures in Part 21-01, Section 2.

1. Clean the joining surfaces of the cylinder head and manifolds.

2. If one of the manifolds is to be replaced, do not remove the tube fittings from the discarded manifold, and install in the new manifold. Only new parts should be used. Install new studs as necessary. If the intake and exhaust manifolds have been separated, position a new gasket on the intake manifold and place the exhaust manifold over the studs on the intake manifold. Install the lock washers and nuts; then tighten them finger-tight. Install the carburetor.

3. Install a new intake manifold gasket.

4. Place a new exhaust manifold to muffler inlet pipe gasket on the muffler inlet pipe.

5. Coat the mating surfaces lightly with graphite grease. Place the manifold assemblies in position against the cylinder head. Make sure that the

gaskets have not become dislodged. Install the attaching washers, bolts and nuts. Torque the bolts and nuts to specifications in the sequence shown in Fig. 5.

If the intake and exhaust manifolds were separated, tighten the nuts joining them.

6. Install the exhaust manifold to muffler inlet pipe lock washers and nuts. Torque the nuts to specifications.

7. Connect the crankcase vent hose to the intake manifold inlet tube, and position the hose clamp.

8. Connect the fuel inlet line and the distributor vacuum line to the carburetor. Connect the power brake vacuum line, if so equipped.

9. Install the alternator. Adjust the alternator drive belt to the specified tension. Connect the distributor vacuum advance control valve (deceleration valve) vacuum hoses at the carburetor and at the intake manifold.

10. Install the accelerator cable bracket on the cylinder head. Connect the accelerator cable to the carburetor and install the retracting spring.

On a vehicle with an automatic transmission, install the bellcrank assembly and kickdown rod retracting spring. Adjust the transmission control linkage (Group 17).

11. Install the air cleaner. Adjust the engine idle speed and idle fuel mixture (Group 23).

#### CRANKCASE VENTILATION SYSTEM

The closed-type crankcase ventilation system components are shown in Fig. 6.

#### REMOVAL

1. Remove the clean air tube at the air cleaner. Remove the oil fill cap.

2. Grasp the crankcase ventilation regulator valve and pull upwards to remove it from the rocker arm cover.

3. Remove the regulator valve from the vent hose and remove the vent hose from the inlet tube in the intake manifold.

4. Remove the inlet tube from the intake manifold.

#### INSTALLATION

The crankcase ventilation regulator valve should not be cleaned. It should be replaced at the specified maintenance interval.

1. Install the inlet tube in the intake manifold.

2. Install the hose on the inlet tube in the intake manifold. Install the regulator valve in the hose.

3. Insert the regulator valve into the rocker arm cover mounting grommet.

4. Connect the clean air tube to the air cleaner. Install the oil fill cap. Operate the engine and check for leaks.

### VALVE ROCKER ARM COVER

#### REMOVAL

1. Disconnect the clean air tube from the oil fill cap. Remove the air cleaner. Remove the distributor vacuum lines and carburetor fuel line. Disconnect all other necessary vacuum lines for accessibility and identify them for proper connection.

2. Disconnect the accelerator cable at the carburetor. Remove the cable retracting spring. Remove the accelerator cable bracket from the cylinder head and position the cable and bracket assembly out of the way.

3. Remove the crankcase ventilation regulator valve from the valve rocker arm cover. Remove the valve rocker arm cover.

#### INSTALLATION

1. Clean the valve rocker arm cover and the cylinder head gasket surface. Apply oil-resistant sealer to one side of a new cover gasket. Lay the cemented side of the gasket in place in the cover. Be sure the gasket is seated properly around the bolt holes.

2. Position the cover on the cylinder head. Make sure the gasket seats evenly all around the head. Partially tighten the cover bolts in sequence, starting at the center bolts. Then torque the bolts to specifications in the same sequence.

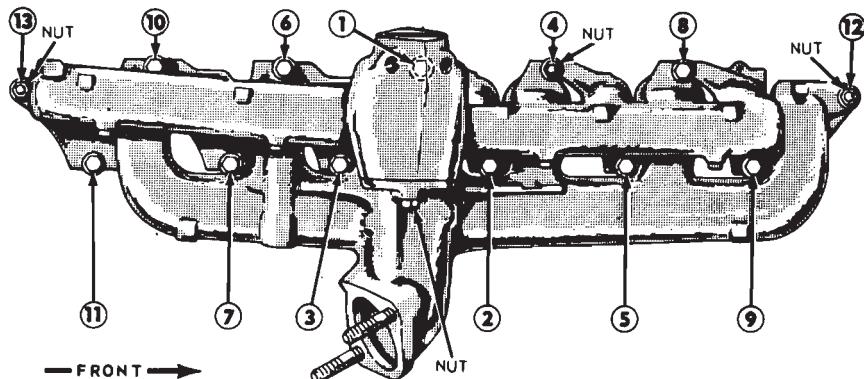
3. Install the accelerator cable bracket on the cylinder head. Connect the accelerator cable to the carburetor. Install the cable retracting spring. Install the distributor vacuum lines and carburetor fuel line.

4. Install the crankcase ventilation regulator valve in the valve rocker arm cover.

5. Install the air cleaner. Connect the clean air tube at the oil fill cap.

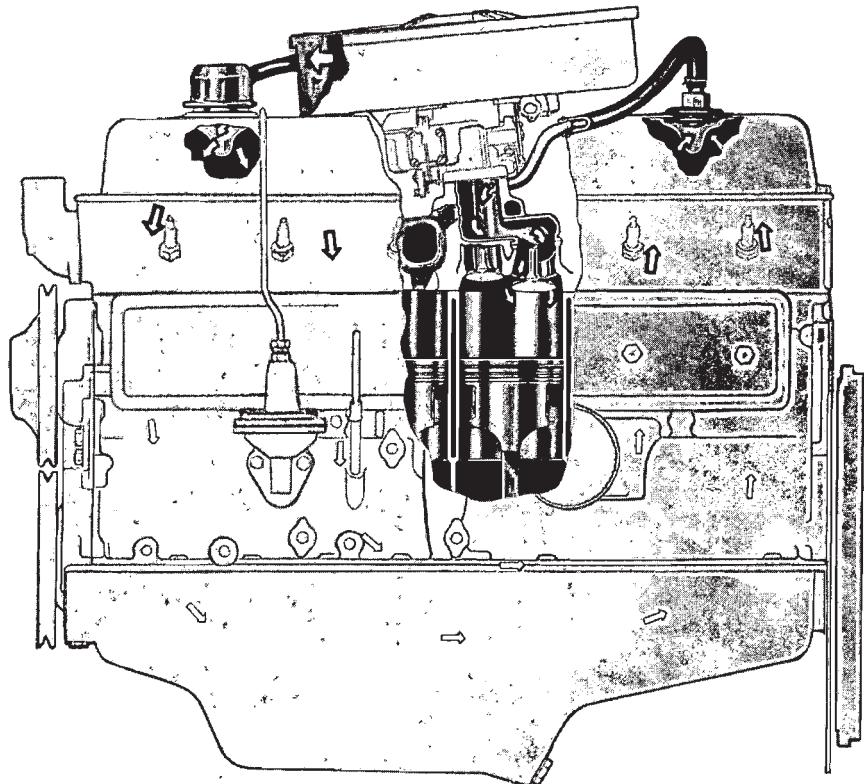
#### VALVE CLEARANCE ADJUSTMENT

Two procedures may be used to adjust the valve clearance. The preferred procedure is recommended, but the



A 3186-A

FIG. 5—Intake and Exhaust Manifold Torque Sequence



A2178-C

FIG. 6—Crankcase Ventilation System

alternate procedure may be used.

#### Preferred Checking Procedure

1. Position No. 1 piston on TDC after the compression stroke. Apply pressure with Tool 6513-AC to slowly bleed down the valve lifter until the plunger is completely bottomed (Fig. 7).

2. While holding the valve lifter in the fully collapsed position, check the available clearance with a feeler gauge between the rocker arm and valve stem tip (Fig. 7). The feeler

gauge width must not exceed 3/8-inch. If the clearance is not within specifications, rotate the rocker arm stud nut clockwise to decrease the clearance and counterclockwise to increase the clearance.

3. With the No. 1 piston on TDC after the compression stroke, use the procedure in step 1 and check the following valves:

No. 1 Intake No. 1 Exhaust  
No. 2 Intake No. 3 Exhaust

No. 4 Intake No. 5 Exhaust

4. Rotate the crankshaft until the No. 6 piston is on TDC after the

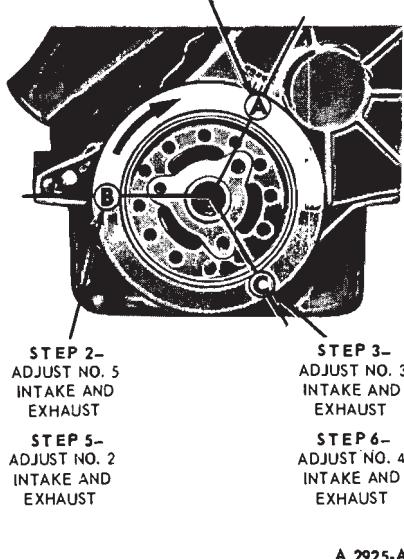
Tool - 6513-AC



**FIG. 7—Checking Valve Clearance**

**STEP 1—SET NO. 1 PISTON ON T.D.C. AT END OF COMPRESSION STROKE ADJUST NO. 1 INTAKE AND EXHAUST**

**STEP 4—ADJUST NO. 6 INTAKE AND EXHAUST**



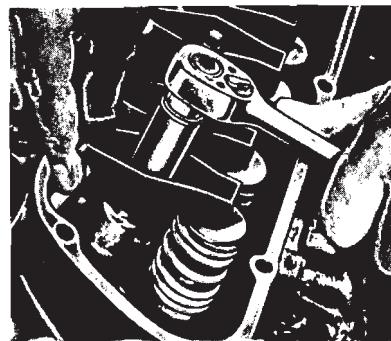
**FIG. 8—Position of Crankshaft for Setting Valve Clearance**

compression stroke (one revolution of the crankshaft). By using the procedure in step 1, check the following valves:

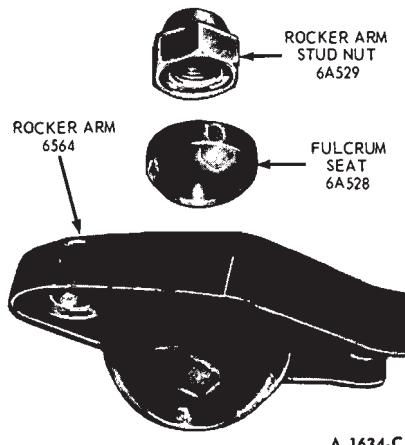
- No. 3 Intake      No. 2 Exhaust
- No. 5 Intake      No. 4 Exhaust
- No. 6 Intake      No. 6 Exhaust

#### Alternate Checking Procedure

1. Disconnect the brown lead (I terminal) and the red and blue lead (S terminal) at the starter relay. Install an auxiliary starter switch between the battery and S terminals of the starter relay. Crank the engine with



**FIG. 9—Valve Clearance Adjustment**



**FIG. 10—Valve Rocker Arm Assembly**

the ignition switch OFF.

2. Make two chalk marks on the crankshaft damper (Fig. 8). Space the marks approximately 120 degrees apart so that with the timing mark, the damper is divided into three equal parts (120 degrees represents 1/3 of the distance around the damper circumference).

3. Rotate the crankshaft until No. 1 piston is on TDC at the end of the compression stroke. Check the breakaway torque (torque required to turn nut in a counterclockwise direction) of each stud nut. Replace the stud nut if the breakaway torque does not meet specifications. If the breakaway torque still is not within specifications, replace the stud.

4. With No. 1 piston on TDC at the end of the compression stroke, adjust the intake and exhaust valve clearance for No. 1 cylinder. Loosen the rocker arm stud nut until there is end clearance in the push rod, then tighten the nut to just remove all the push rod to rocker arm clearance. This may be determined by rotating

and/or moving the push rod with the fingers as the stud nut is tightened (Fig. 9). When the push rod to rocker arm clearance has been eliminated, tighten the stud nut an additional one full turn to place the hydraulic lifter plunger in the desired operating range.

5. Repeat this procedure for the remaining set of valves, turning the crankshaft with an auxiliary starter switch, 1/3 turn at a time in the direction of rotation, while adjusting the valves in the firing order sequence. The firing order is 1-5-3-6-2-4.

This procedure requires two complete turns of the crankshaft.

6. Operate the engine and check for rough engine idle or a noisy lifter(s). Valve clearance set too tight will cause rough engine idle, and valve clearance set too loose will cause a noisy lifter(s).

## VALVE ROCKER ARM ASSEMBLY

The valve rocker arm assembly is shown in Fig. 10.

### REMOVAL

1. Remove the valve rocker arm cover following the procedures under Valve Rocker Arm Cover Removal.

2. Remove the valve rocker arm stud nut, fulcrum seat and rocker arm. If the torque required to turn the adjusting nut (counterclockwise) is below specifications, replace the nut.

3. If removal of the rocker arm stud is necessary, refer to the procedure under Cylinder Head Repairs in Part 21-01, Section 2.

### INSTALLATION

1. Check the inner wear surfaces of the guide rails. Parts with excess wear or damage should be replaced.

2. Apply Lubriplate to the top of the valve stem and at the push rod guide in the cylinder head.

3. Lubricate and install the valve rocker arm, fulcrum seat and stud nut. Adjust the valve clearance.

4. Install the valve rocker arm cover following the procedures under Valve Rocker Arm Cover Installation.

## CYLINDER HEAD

### REMOVAL

If the cylinder head is to be replaced, follow the procedures under

Cylinder Head Disassembly and Assembly, and transfer all valves, springs, seals, spark plugs, etc., to the new cylinder head. Clean and inspect all parts, reface the valves and check valve guide clearances (refer to Part 21-01) before assembling the used parts to the new cylinder head.

1. Drain the cooling system. Remove the air cleaner.
2. Disconnect the radiator upper hose and the heater hose from the coolant outlet housing.
3. Disconnect the coolant temperature sending unit wire from the sending unit.
4. Disconnect and remove the carburetor fuel inlet line and the distributor vacuum lines. Disconnect vacuum lines as necessary for accessibility, and identify them for proper connection.

5. Remove the accelerator cable retracting spring. Disconnect the accelerator cable housing bracket from the cylinder head and position the cable and bracket assembly out of the way.

On a vehicle with an automatic transmission, disconnect the kickdown rod at the bellcrank assembly.

6. Grasp the crankcase ventilation regulator valve and pull it from the rocker arm cover. Disconnect the crankcase vent hose from the inlet tube in the intake manifold, and remove the vent hose and regulator valve.

7. On a vehicle with power brakes, disconnect the power brake vacuum line at the intake manifold.

8. Remove the valve rocker arm cover. Loosen the rocker arm stud nuts so that the rocker arms can be rotated to one side.

9. Remove the valve push rods in sequence and identify them so that they can be installed in the original position.

10. Disconnect the spark plug wires at the spark plugs.

11. Disconnect the muffler inlet pipe from the exhaust manifold. Discard the inlet pipe gasket.

12. Remove the cylinder head bolts. Install the cylinder head lifting eyes in the locations shown in Fig. 11. Attach a hoist and lifting sling to the lifting eyes, and lift the cylinder head and intake and exhaust manifolds assembly off the engine. Do not pry between the head and block as the gasket surfaces may become damaged.

## INSTALLATION

1. Clean the cylinder head and cylinder block gasket surfaces. Clean the

exhaust manifold and muffler inlet pipe gasket surfaces.

2. If the cylinder head was removed for a cylinder head gasket replacement, check the flatness of the head and block gasket surfaces (Part 21-01, Section 3).

3. Position the gasket over the dowel pins on the cylinder block.

4. Install lifting eyes on the cylinder head in the locations shown in Fig. 11, and use a hoist and lifting sling to lift the cylinder head over the cylinder block. Lower it carefully until it is properly positioned on the block and dowel pins. Remove the hoist and lifting eyes.

5. Coat the threads of the cylinder head bolts with engine oil. Install the bolts.

6. The cylinder head bolts are tightened in three progressive steps. Follow the sequence shown in Fig. 11. Torque the bolts to 50-55 ft-lbs, then to 60-65 ft-lbs. Finally, torque the bolts to specifications. When cylinder head bolts have been tightened following this procedure, it is not necessary to retorque the bolts after extended operation. However, the bolts may be checked and retorqued, if desired.

7. Position a new gasket on the muffler inlet pipe and connect the inlet pipe to the exhaust manifold. Torque the nuts to specifications.

8. Apply Lubriplate to both ends of the push rods, to the valve stem tips, and to the fulcrum seat of the rocker arms. Install the push rods in the original bores, positioning the lower end of the rods in the valve lifter sockets.

9. Position the rocker arms and tighten the stud nuts just enough to hold the push rods in position. Adjust the valve lash, following the procedure in Part 21-01, Section 2.

10. Clean the valve rocker arm cover. Coat one side of a new valve rocker arm cover gasket with oil-resistant sealer. Lay the cemented side of the gasket in place in the cover. Install the cover, making sure that the gasket seats evenly around the cylinder head.

Torque the cover bolts to specifications.

11. On a vehicle with power brakes, connect the brake vacuum line to the intake manifold.

12. Connect the spark plug wires to the spark plugs.

13. Connect the crankcase vent hose to the inlet tube in the intake manifold. Install the crankcase ventilation regulator valve in the valve

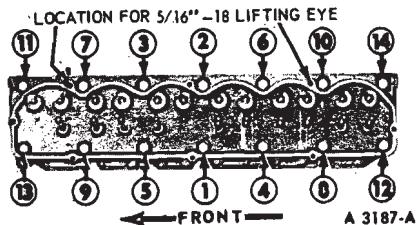


FIG. 11—Cylinder Head Torque Sequence

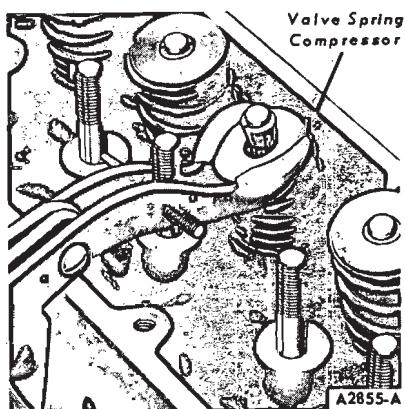


FIG. 12—Compressing Valve Spring on Bench—Typical

rocker arm cover.

14. Position the fuel inlet line and the distributor vacuum lines on the engine. Connect the distributor vacuum lines to the distributor, carburetor and the intake manifold. Connect the carburetor fuel inlet line to the carburetor and the fuel pump.

15. Install the accelerator cable bracket on the cylinder head. Connect the accelerator cable and install the accelerator cable retracting spring.

On a vehicle with an automatic transmission, connect the kickdown rod to the bellcrank assembly.

16. Connect the coolant temperature sending unit wire.

17. Connect the radiator upper hose to the coolant outlet housing. Connect the heater hose to the coolant outlet housing, but do not tighten the clamp.

18. Fill and bleed the cooling system; then tighten the heater hose clamp.

19. Operate the engine until engine temperatures have stabilized. Adjust the engine idle speed and idle fuel mixture. Check for fuel, oil and coolant leaks.

On a vehicle with an automatic transmission, adjust the transmission control linkage if necessary.

20. Install the air cleaner.

## DISASSEMBLY

1. Remove the coolant outlet housing and thermostat. Discard the gasket.
2. Remove the coolant temperature sending unit from the cylinder head.
3. Remove the intake manifold, exhaust manifold and carburetor assembly from the cylinder head. Discard the gasket.
4. Remove the spark plugs.
5. If the cylinder head is being repaired, remove the deposits from the combustion chambers and valve heads with a scraper and a wire brush before removing the valves. Be careful not to scratch the cylinder head gasket surface.
6. Compress the valve springs (Fig. 12); then remove the valve spring retainer locks and release the spring.
7. Remove the spring retainer, spring, stem seal and valve (Fig. 13). Discard the valve stem seals. Identify all valve parts so that they may be installed in the original position.
8. Clean, inspect and repair the cylinder head, valves, rocker arms and studs, and valve springs as required (Part 21-01). Check the cylinder head flatness. If the cylinder head is not repairable, transfer all usable parts to a new cylinder head.

## ASSEMBLY

1. All valves, valve stems and valve

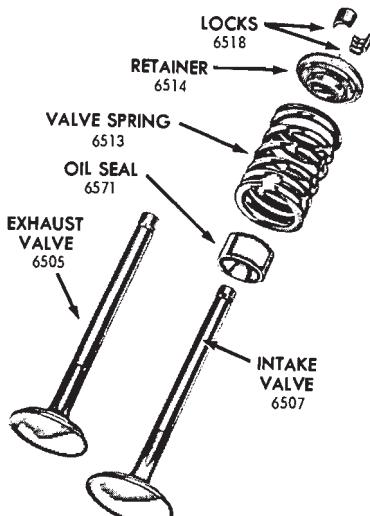
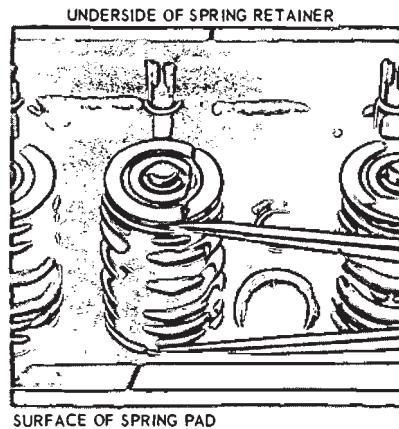


FIG. 13—Valve Assembly—Typical

A2856-A



A2857-B

FIG. 14—Valve Spring Assembled Height—Typical

guides are to be lubricated with heavy oil MS. The valve tips are to have lubriplate, or equivalent, applied. The lubricant is to be applied before installation.

2. Install each valve (Fig. 13) in the valve guide from which it was removed or to which it was fitted. Install a new stem seal on the valve.

3. Install the valve spring over the valve. Be sure the closed coil end is placed against the cylinder head. Install the spring retainer.

4. Compress the spring and install the retainer locks (Fig. 12).

5. Measure the assembled height of the valve spring from the surface of the cylinder head spring pad to the underside of the spring retainer with dividers (Fig. 14).

Check the dividers against a scale. If the assembled height is greater than the specified limit, install the necessary 0.030-inch thick spacer(s) between the cylinder head spring pad and the valve spring to bring the assembled height to the recommended dimension. Do not install spacers unless necessary. Use of spacers in excess of recommendations will result in overstressing the valve springs and overloading the camshaft lobes which could lead to spring breakage and worn camshaft lobes.

6. Position a new intake manifold gasket on the cylinder head. Install the intake manifold, exhaust manifold and carburetor assembly. Torque the manifold bolts and nuts in sequence (Fig. 5) to specifications.

7. Install the temperature sending unit. Install the spark plugs.

8. Using a new coolant outlet elbow gasket coated with water-resistant sealer, install the thermostat

and coolant outlet elbow. Torque the attaching bolts to specifications.

## VALVE SPRING, RETAINER AND STEM SEAL

Broken valve springs, or defective valve stem seals and retainers may be replaced without removing the cylinder head, provided damage to the valve or valve seat has not occurred.

## REMOVAL

1. Remove the air cleaner. Remove the distributor vacuum lines and carburetor fuel-line. Disconnect vacuum lines as necessary for accessibility and identify them for proper connection.

2. Remove the accelerator cable retracting spring. Disconnect the accelerator cable at the carburetor. Remove the accelerator cable housing bracket from the cylinder head and position the accelerator cable assembly out of the way.

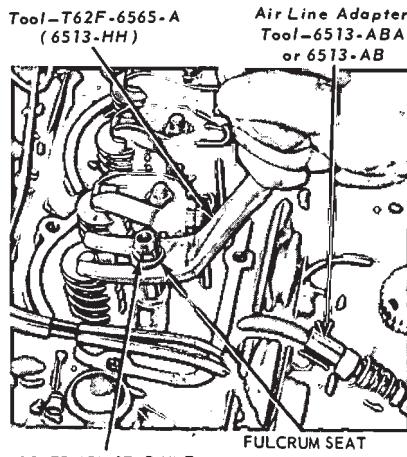
3. Remove the crankcase ventilation regulator valve from the valve rocker arm cover and remove the valve rocker arm cover. Remove the applicable spark plug.

4. Remove the valve rocker arm stud nut, fulcrum seat, valve rocker arm and push rod for both valves of the cylinder being serviced.

5. Install an air line adapter in the spark plug hole (Fig. 15) and connect the air line.

6. Install the stud nut and position the compressor tool as shown in Fig. 15. Compress the valve spring and remove the retainer locks, spring retainer and valve spring. Remove and discard the valve stem seal (Fig. 16).

7. If air pressure has forced the



A2141-A

FIG. 15—Compressing Valve Spring-In Chassis

piston to the bottom of the cylinder any removal of air pressure will allow the valve(s) to fall into the cylinder. A rubber band, tape or string wrapped around the end of the valve stem will prevent this condition and will still allow enough travel to check the valve for binds.

8. Inspect the valve stem for damage. Rotate the valve and check the valve stem tip for eccentric movement during rotation. Move the valve up and down through normal travel in the valve guide and check the stem for binds. If the valve has been damaged, it will be necessary to remove the cylinder head for repairs as outlined in Part 21-01, Section 2.

9. If the condition of the valve proved satisfactory, hold the valve in the closed position and apply the air pressure within the cylinder.

#### INSTALLATION

1. Install a new valve stem seal (Fig. 16). Place the spring in position over the valve; be sure the closed coil end is next to the cylinder head. Install the valve spring retainer. Compress the valve spring and install the valve spring retainer locks. Remove the compressor tool and stud nut.

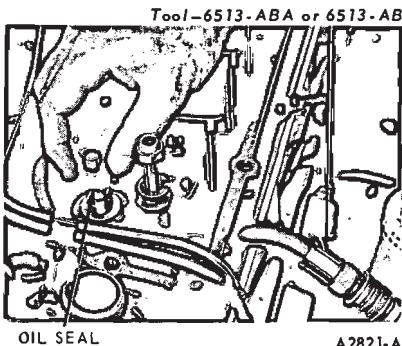


FIG. 16—Valve Stem Seal Removal or Installation

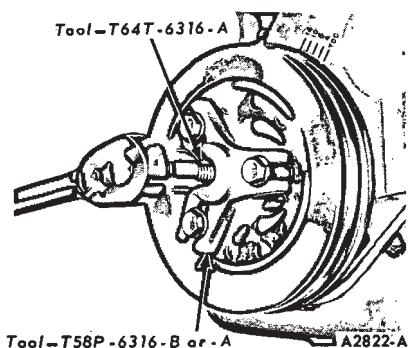


FIG. 17—Removing Crankshaft Damper-Typical

Turn off the air and remove the air line and adapter.

2. Apply Lubriplate to both ends of the push rod. Install the push rod. Apply Lubriplate to the tip of the valve stem and at the push rod guide in the cylinder head.

3. Lubricate and install the valve rocker arm, fulcrum seat and stud nut with heavy oil MS. Adjust the valve clearance.

4. Install the spark plug and connect the spark plug wire.

5. Clean the valve rocker arm cover. Coat one side of a new gasket with oil-resistant sealer. Position the gasket on the rocker arm cover; be sure the cemented side is towards the cover. Install the cover, making sure that the gasket seats evenly around the cylinder head. Torque the cover bolts in sequence to specifications.

6. Install the accelerator cable housing bracket on the cylinder head. Connect the accelerator cable to the carburetor. Install the accelerator cable retracting spring. Install the distributor vacuum lines and carburetor fuel line. Connect all vacuum lines using previous identification for proper connection.

7. Install the crankcase ventilation regulator valve in the valve rocker arm cover. Install the air cleaner.

#### WATER PUMP

##### REMOVAL

1. Drain the cooling system.

2. Loosen and remove the alternator, power steering, and air conditioning drive belts as necessary.

3. Disconnect the radiator lower hose and heater hose at the water pump. Remove the fan, spacer, pulley and drive belt.

4. Remove the four bolts attaching the water pump to the block; then remove the pump.

5. Trim the water pump section of the front cover gasket flush with the front cover. Clean all old gasket material from the cylinder block.

#### INSTALLATION

If the water pump is damaged, replace it.

1. If a new water pump is to be installed, remove the heater hose fitting from the old pump and install it on the new pump. Clean all gasket material from the mounting surface of the water pump if it is being reinstalled.

2. Position a new gasket, coated on

both sides with water-resistant sealer, on the cylinder block. Position the pump body to the block. Install and torque the attaching bolts to specifications.

3. Install the pulley, spacer and fan. Install the drive belt and adjust the belt tension.

4. Position the power steering, and air conditioning drive belts, if so equipped, and adjust the belt tension to specifications. Connect the radiator hose and heater hose. Fill and bleed the cooling system. Operate the engine and check for leaks.

#### CYLINDER FRONT COVER

##### REMOVAL

1. Drain the cooling system.

On a vehicle with an automatic transmission, disconnect the transmission oil cooler lines from the radiator.

2. Disconnect the radiator upper hose from the coolant outlet housing and the radiator lower hose at the water pump. Remove the radiator.

On a vehicle with air conditioning, remove the condenser attaching bolts, and position the condenser to one side for accessibility. Do not disconnect the condenser refrigerant lines. Remove the compressor drive belt.

3. On a vehicle with power steering, loosen the nut attaching the power steering pump to the pump rear mounting bracket. Remove two bolts attaching the pump front mounting bracket to the cylinder front cover. Remove the power steering pump and mounting bracket out of the way.

4. Remove the cooling fan and alternator drive belts. Remove the alternator adjusting arm bolt, and swing the adjusting arm out of the way. Remove the fan, spacer and pulley.

5. Remove the accessory drive pulley (if so equipped) from the crankshaft damper. Remove the cap screw and washer from the end of the crankshaft; then remove the damper (Fig. 17).

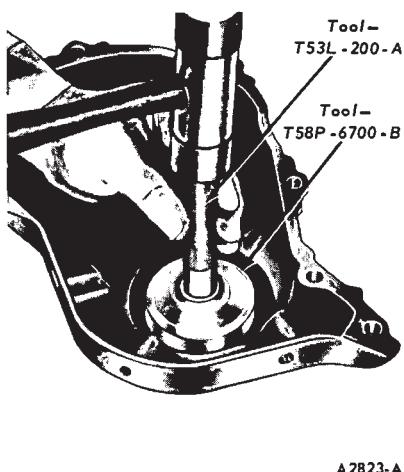
6. Remove the oil level dipstick.

7. Remove the cylinder front cover and accessory drive belt idler pulley assembly (if so equipped), and discard the gasket.

8. Raise the vehicle on a hoist. Drain the engine crankcase.

9. Disconnect the starter cable at the starter. Remove the attaching bolts and remove the starter.

10. Remove the engine front sup-



**FIG. 18—Installing Crankshaft Front Oil Seal**

port insulator to intermediate support bracket nuts on both supports. Remove the engine rear support insulator to crossmember bolt and insulator to transmission extension housing bolts. Raise the transmission, remove the support insulator, and lower the transmission to the crossmember.

11. Raise the engine with a transmission jack and place 2-inch thick wood blocks between both front support insulators and intermediate support brackets.

12. Remove the oil pan following the procedures under Oil Pan Removal.

#### Crankshaft Front Oil Seal Replacement

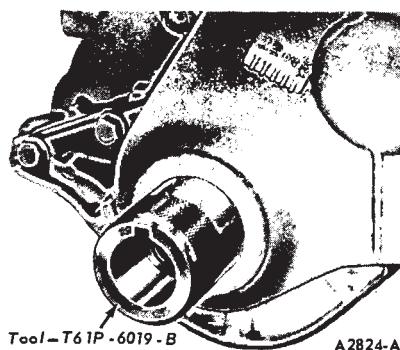
1. Drive out the old seal with a pin punch. Clean out the recess in the cover.

2. Coat a new seal with grease, and install the seal (Fig. 18). Drive the seal in until it is fully seated in the recess. After installation, check to be sure the seal is properly positioned in the cover and the spring is properly positioned in the seal.

#### INSTALLATION

1. Coat the gasket surface of the block and cover with oil-resistant sealer. Position a new gasket on the block.

2. Insert the small diameter end of the cover alignment tool in the bore of the cover. Position the cover and pilot assembly over the end of the crankshaft and against the block (Fig. 19) being careful to align the cover flush with the cylinder block oil pan gasket surface.



**FIG. 19—Aligning Cylinder Front Cover**

3. Install the accessory drive belt idler pulley assembly (if so equipped) and attaching bolts. Install the alternator adjusting arm and cylinder front cover bolts. Torque all the bolts except the power steering pump bracket bolts (if so equipped) to specifications.

4. Lubricate the crankshaft with a white lead and oil mixture to facilitate installation of the damper. Lubricate the front oil seal rubbing surface on the damper inner hub and the inner surface (sealing area) of the oil seal with Lubri-plate.

5. Align the damper keyway with the key on the crankshaft, clean the crankshaft damper. Install the damper on the crankshaft (Fig. 20).

6. Install the washer and cap screw. Torque the cap screw to specifications.

Install the accessory drive pulley (if so equipped) on the crankshaft damper. Torque the bolts to specifications.

7. Clean and install the oil pump screen and inlet tube assembly.

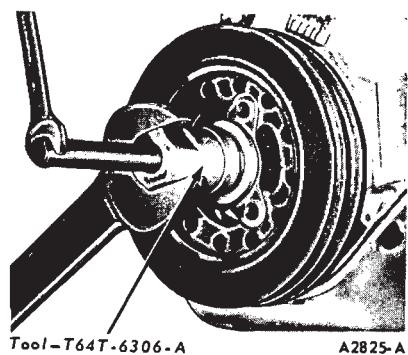
8. Clean the gasket surfaces of the oil pump, oil pan and cylinder block. Remove the rear main bearing cap to oil pan seal and cylinder front cover to oil pan seal. Clean the seal grooves.

9. Install the oil pan with new gaskets and seals, following the procedures under Oil Pan Installation.

10. Install the water pump pulley(s), spacer and fan. Install the cooling fan and alternator drive belts.

On a vehicle with power steering, install the power steering pump and front mounting bracket assembly. Torque the mounting bracket to cylinder front cover and cylinder block bolts to specification. Install the power steering drive belt. Torque the adjusting nut and bolts to specifications.

11. On a vehicle with air conditioning, position the condenser, and in-



**FIG. 20—Installing Crankshaft Damper-Typical**

stall the attaching bolts. Install the compressor drive belt.

12. Adjust the tension of all the drive belts to specifications.

13. Install the radiator. Connect the radiator lower hose at the water pump and the radiator upper hose at the coolant outlet housing.

On a vehicle with an automatic transmission, connect the transmission oil cooler lines.

14. Fill and bleed the cooling system. Install the oil level dipstick. Fill the crankcase.

15. Operate the engine at fast idle and check all hose connections and gaskets for leaks.

#### TIMING GEARS

The engine has a gear driven cam-shaft. When the crankshaft and cam-shaft lose their timing relationship through the removal of the timing gears, interference may occur between the crankshaft and cam lobes if either the camshaft or crankshaft are rotated. Therefore, to prevent possible damage to the camshaft lobes, do not rotate the camshaft or crankshaft in the engine without the timing gears installed.

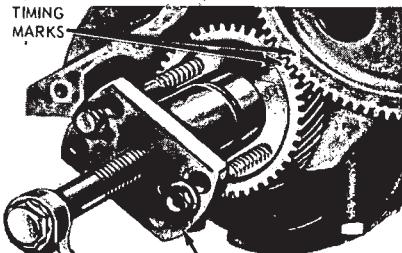
#### REMOVAL

1. Drain the cooling system and crankcase.

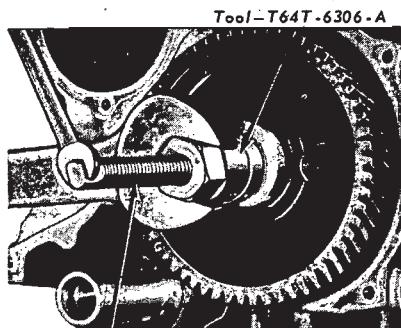
2. Remove the cylinder front cover and camshaft following the procedures in this section.

3. Remove the oil slinger from the crankshaft. Use the gear puller as shown in Fig. 21 and remove the crankshaft gear. Remove the key from the crankshaft.

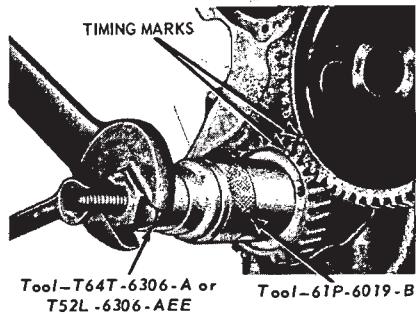
4. Press the camshaft gear off the camshaft in an arbor press (Fig. 22). Remove the thrust plate, spacer and key.



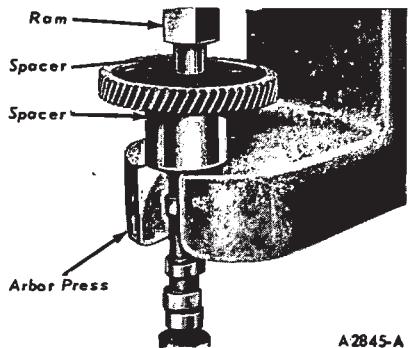
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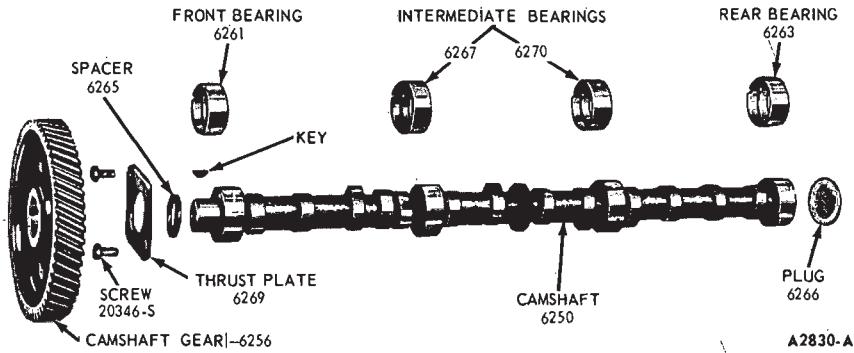
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**FIG. 21—Removing Crankshaft Gear**

A2845-A

**FIG. 22—Removing Camshaft Gear****INSTALLATION**

1. Place the spacer and thrust plate on the camshaft.
2. Install the key in the camshaft. Align the keyway in the gear with the key, then press the gear onto the shaft (Fig. 23), making sure that it seats tight against the spacer.
3. Check the camshaft end play by inserting a feeler gauge between the thrust plate and gear or the front bearing journal of the camshaft. This clearance will determine the camshaft end play. If not within specifications, replace the thrust plate.
4. Install the crankshaft gear (Fig. 24).
5. Oil the camshaft journals and apply Lubriplate, to all the lobes. Carefully slide the camshaft through the bearings making sure the timing marks are in alignment when the gears are engaged (Fig. 26). Install and torque the thrust plate attaching screws.
6. Lubricate the hydraulic lifters and install them in the same bores from which they were removed.
7. Install the push rods in the same bores from which they were removed.
8. Adjust the valve lash as required.

**FIG. 23—Installing Camshaft Gear**

A2830-A

**FIG. 25—Camshaft and Related Parts**

9. Install the valve cover, crankcase ventilation regulator and the air cleaner.
10. Install a new side cover gasket and the cover.
11. Install the cylinder front cover following the procedures in this section.
12. Fill the cooling system. Start the engine and adjust the ignition timing. Operate the engine at fast idle and check all hose connections and gaskets for leaks.

**CAMSHAFT**

The camshaft and related parts are shown in Fig. 25.

**REMOVAL**

1. Drain the cooling system and the crankcase.
2. Remove the air cleaner. Remove the crankcase ventilation regulator valve from the valve rocker arm cover.
3. Disconnect the accelerator cable at the carburetor. Remove the accelerator cable retracting spring. Remove the accelerator cable housing bracket from the cylinder head and position the cable and bracket assembly out of the way. Remove the valve

**FIG. 26—Aligning Timing Marks**

rocker arm cover.

On a vehicle with air conditioning, remove the condenser attaching bolts, and position the condenser to one side for accessibility. Do not disconnect condenser refrigerant lines.

4. Remove the radiator retaining bracket and lift the radiator from the vehicle. Mark the location of the grille center support and hood lock assembly in relation to the radiator and front fender arm support.

Remove the grille, center support, and hood lock as a unit.

Remove the cylinder front cover, following the procedure under Cylinder Front Cover Removal.

5. Disconnect the spark plug wires

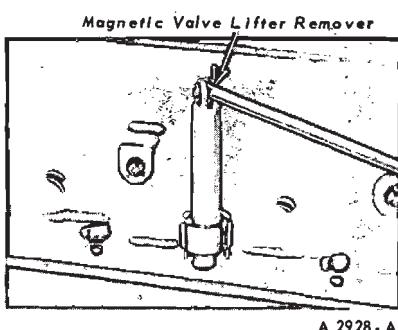


FIG. 27—Removing or Installing Valve Lifters

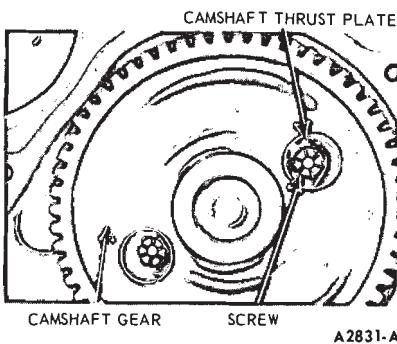


FIG. 28—Removing or Installing Camshaft

at the spark plugs and disconnect the high tension wire at the ignition coil. Remove the distributor cap and spark plug wires as an assembly.

6. Disconnect the fuel outlet line at the fuel pump. Remove the fuel pump mounting bolts and position the fuel pump out of the way.

7. Disconnect the vacuum line at the distributor and the primary wire at the coil. Remove the distributor.

8. Loosen the rocker arm stud nuts; move the rocker arms to one side, and remove the push rods in sequence. Place the push rods in a rack so they can be installed in the original location.

9. Remove the valve push rod cover; then remove the valve lifters in sequence, using the tool shown in Fig. 27. Place the valve lifters in a tray or rack to facilitate installation in the same bores from which they were removed.

10. Turn the crankshaft to align the timing marks as shown in Fig. 26. Remove the camshaft thrust plate screws (Fig. 28).

11. Carefully remove the camshaft with the gear attached. Avoid damaging the camshaft lobes during removal.

12. Press the camshaft out of the

camshaft gear in an arbor press (Fig. 22). Remove the key, thrust plate and spacer.

## INSTALLATION

1. Place the spacer and thrust plate on the camshaft.

2. Install the key in the camshaft. Align the keyway in the gear with the key, then press the gear onto the shaft, making sure that it seats tight against the spacer.

3. Check the camshaft end play by inserting a feeler gauge between the thrust plate and gear or the front bearing journal of the camshaft. This clearance will determine the camshaft end play. If not within specifications, replace the thrust plate.

4. Oil the camshaft journals and apply Lubriplate to all the lobes. Carefully slide the camshaft through the bearings making sure the timing marks are in alignment when the gears are engaged. Install and torque the thrust plate attaching screws.

5. Check the backlash between the camshaft gear and crankshaft gear with a dial indicator (Part 21-01, Section 1). Hold the gear firmly against the block while making the check. Refer to the specifications for the backlash limits.

6. Check the camshaft gear runout and end play with a dial indicator (Part 21-01, Section 1). If the gear runout is excessive, remove the gear and remove any burrs from the shaft, or replace the gear.

7. Lubricate the hydraulic lifters and install them in the same bores from which they were removed.

8. Install the push rods in the same bores from which they were removed.

9. Adjust the valve lash as required.

10. Install the valve cover, crankcase ventilation regulator and the air cleaner.

11. Install a new side cover gasket and the cover.

12. Crank the engine until the timing marks are aligned as shown in Fig. 26.

13. Set the distributor rotor so the points are about to open for No. 1 cylinder firing position. Install the distributor. Check the points. If the camshaft timing marks are still aligned (step 6), the points should be fully open in No. 1 cylinder firing position. If the points are not open, remove the distributor and rotate the shaft in the proper direction. Install the distributor and hold-down clamp.

14. Clean the cylinder front cover

and cylinder block gasket surfaces.

15. Install a new oil seal in the cylinder front cover. Install the cylinder front cover, crankshaft damper and accessory drive belts, following the procedures under Cylinder Front Cover Installation. Adjust the drive belt tension to specifications.

16. Connect the distributor primary wire at the ignition coil. Connect the vacuum line to the distributor.

17. Clean the fuel pump and cylinder block gasket surfaces. Install the fuel pump with a new gasket. Torque the mounting bolts to specifications. Connect the fuel outlet line to the fuel pump.

18. Install the distributor cap and spark plug wires. Connect the spark plug wires.

19. Install the crankcase ventilation regulator valve in the valve rocker arm cover. Install the accelerator cable housing bracket on the cylinder head. Connect the accelerator cable to the carburetor. Install the cable retracting spring.

20. On a vehicle with air conditioning, position the condenser and install the attaching bolts.

21. Position the radiator and install the retaining bracket. Connect the radiator upper hose to the coolant outlet housing, and connect the lower hose to the water pump. Install the hood latch support bracket and the radiator grille assembly.

22. Install the air cleaner.

23. Fill the crankcase and cooling systems.

24. Start the engine and check for oil, coolant and fuel leaks. Adjust the ignition timing. Adjust the carburetor idle speed and fuel mixture.

## CAMSHAFT REAR BEARING BORE PLUG REPLACEMENT

1. On an automatic transmission, remove the transmission fluid level dipstick and tube. Dispose of the fluid drained at the dipstick tube opening.

Disconnect the transmission shift linkage and drive shaft. Support the transmission on a transmission jack. Disconnect the transmission at the engine and at the support insulator. Move the transmission and converter (automatic transmission) to one side, leaving it on the transmission jack. **Do not drain the converter.**

On a manual-shift transmission, remove the clutch pressure plate and disc following the procedure in Group 16.

2. Remove the flywheel attaching

bolts. Remove the flywheel and the engine rear cover.

3. Replace the bore plug as detailed in Part 21-01, Section 2.

4. Install the engine rear cover plate and flywheel. Coat the threads of the flywheel attaching bolts with oil-resistant sealer, and install the bolts. Torque the bolts in sequence across from each other to specifications.

On a vehicle with a manual-shift transmission, install the clutch pressure plate and disc, following the procedure in Group 16.

5. Install the transmission. Torque all attaching bolts to specifications. Connect the driveshaft and transmission shift linkage. Remove the transmission jack. Install the fluid level dipstick and tube (if so equipped). Add transmission fluid as necessary.

## VALVE LIFTERS

### REMOVAL

Before replacing a hydraulic valve lifter for noisy operation, be sure the noise is not caused by improperly adjusted valve lash or by worn rocker arms or push rods.

1. Remove the air cleaner. Remove the crankcase ventilation regulator valve from the valve rocker arm cover.

2. Disconnect the accelerator cable at the carburetor. Remove the retracting spring. Remove the accelerator cable housing bracket from the cylinder head. Position the cable and bracket assembly out of the way. Disconnect and identify vacuum hoses as necessary for accessibility.

3. Remove the valve rocker arm cover.

4. Disconnect the spark plug wires at the spark plugs. Remove the valve push rod cover.

5. Loosen the rocker arm stud nut(s) until the rocker arm(s) can be disengaged from the push rod(s). Remove the push rod(s). Remove the valve lifter(s) with the tool shown in Fig. 27. If more than one push rod and valve lifter is removed, place the parts in a rack so they can be installed in their original location.

### INSTALLATION

If the valve lifters are to be tested or disassembled and cleaned, follow the procedures in Part 21-01. If a hydraulic valve lifter has been disassembled and cleaned, be sure to fill it with test fluid before installing it in the engine. New valve lifters already contain test fluid.

1. Clean the rocker arm cover, push rod cover, and cylinder head and block gasket surfaces.

2. Apply Lubriplate to the cam lobe contact surface of the valve lifter(s). Install the valve lifters with the tool shown in Fig. 27.

3. Apply Lubriplate to both ends of the push rod(s). Install the push rod(s) in the same opening from which they were removed. Engage the rocker arm(s) with the push rod(s) and tighten the rocker arm stud nut(s) sufficiently to hold the push rod(s) in place. Be sure the push rod(s) is properly seated in the valve lifter socket(s).

4. Adjust the valve clearance, following the procedure in Part 21-01, Section 2.

5. Coat one side of new gaskets with oil-resistant sealer and position the gaskets, cemented side toward covers, on the rocker arm and push rod covers. Install the push rod cover and the rocker arm cover. Torque the cover screws in sequence to specifications.

6. Connect the spark plug wires.

7. Install the accelerator cable housing bracket on the cylinder head. Connect the accelerator cable to the carburetor. Install the cable retracting spring. Connect all vacuum lines using previous identification for proper connection.

8. Start the engine and adjust the carburetor idle speed and mixture. Install the air cleaner.

### VALVE LIFTER DISASSEMBLY AND ASSEMBLY

The disassembly and assembly procedures for Types I and II valve lifters are different. Valve lifters should always be tested after assembly; refer to the test procedure covered in Part 21-01.

#### Disassembly

The type I hydraulic valve lifter assembly is shown in Fig. 29.

Each valve lifter is a matched assembly. If the parts of one lifter are intermixed with those of another, improper valve operation may result. Disassemble and assemble each lifter separately. Keep the lifter assemblies in a rack so that they can be installed in their original bores.

1. Grasp the lock ring with needle nose pliers to release it from the groove. It may be necessary to depress the plunger to fully release the lock ring.

2. Remove the push rod cup, me-

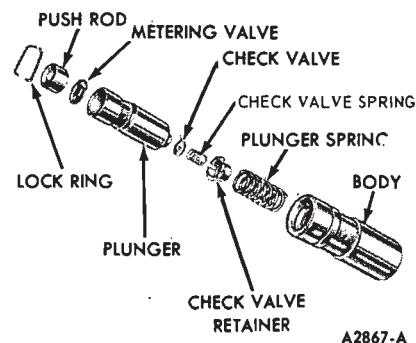


FIG. 29—Type I Hydraulic Valve Lifter-Disassembled

tering valve (disc), plunger and spring.

3. Invert the plunger assembly and remove the check valve retainer by carefully prying up on it with a screw driver. Remove the check valve (disc or ball check) and spring.

#### Assembly

1. Clean the parts. Place the plunger upside down on a clean work bench.

2. Place the check valve (disc or ball check) in position over the oil hole on the bottom of the plunger. Set the check valve spring on top of the check valve (disc or ball check).

3. Position the check valve retainer over the check valve and spring and push the retainer down into place on the plunger.

4. Place the plunger spring, and then the plunger (open end up) into the lifter body.

5. Position the metering valve (disc) in the plunger, and then place the push rod cup in the plunger.

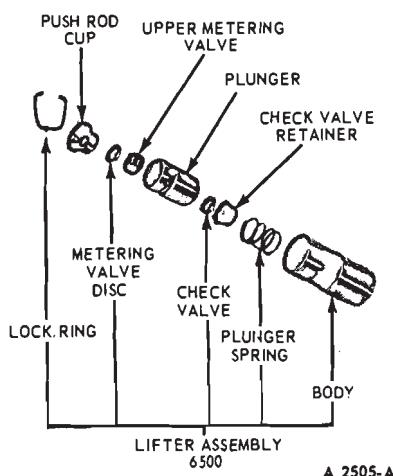
6. Depress the plunger, and position the closed end of the lock ring in the groove of the lifter body. With the plunger still depressed, position the open ends of the lock ring in the groove. Release the plunger, and then depress it again to fully seat the lock ring.

#### TYPE II

#### Disassembly

The type II hydraulic lifter assembly is shown in Fig. 30.

Each valve lifter is a matched assembly. If parts of one lifter are intermixed with those of another, improper valve operation may result. Disassemble and assemble each lifter separately. Keep the lifter assemblies in proper sequence so they can be installed in their original bores.



**FIG. 30—Type II Hydraulic Valve Lifter-Disassembled**

1. Grasp the lock ring with needle nose pliers to release it from the groove. It may be necessary to depress the plunger to fully release the lock ring.

2. Remove the push rod cup, metering valve disc, and the upper metering valve. **Do not bend the metering valve or the valve tensioning finger.**

3. Remove the plunger assembly, the check valve and the check valve retainer and plunger spring. Carefully remove the plunger spring, the check valve retainer and the check valve disc from the plunger.

#### Assembly

1. Place the plunger on a clean work surface (table or bench) in an inverted position and center the check valve disc on it. Carefully slide the check valve over the disc and down until it bottoms. A slight turning motion will help this. **Use every precaution not to distort it in any way, or to bend the preformed fingers.** With a slight turning motion slide the plunger spring over the metering valve and down until it seats.

2. Leaving the assembly in the inverted position, slide the lifter body down over the spring until it slightly compresses the spring.

3. Position the combined assembly right side up on the work surface (table or bench).

4. Position the upper metering valve in the plunger taking care not to tilt it to either side, and not to damage or bend the valve tensioning finger. Place the metering valve disc over the metering valve and install the push

rod cup. Depress the cup and install the lock ring.

#### MAIN AND CONNECTING ROD BEARINGS

The main and connecting rod bearing inserts are selective fit. **Do not file or lap bearing caps or use shims to obtain the proper bearing clearance.**

Selective fit bearings are available for service in standard sizes, 0.001, 0.002, 0.010, 0.020, 0.030 and 0.040 inch undersize. Refer to the Parts Catalog for the available sizes. Undersize bearings, which are not selective fit, are available for use on journals that have been refinished.

#### MAIN BEARINGS

Since the one-piece crankshaft rear oil seal must be replaced when the rear crankshaft bearings are replaced, it is necessary to remove the engine from the vehicle for main bearing replacement:

Refer to Engine Removal and Main Bearing Installation procedures.

#### CONNECTING ROD BEARINGS

##### Removal

1. Drain the crankcase. Remove the oil pan and oil pump, following the procedure under Oil Pan Removal.

2. Turn the crankshaft until the connecting rod to which new bearings are to be fitted is down. Remove the connecting rod cap. Remove the bearing inserts from the rod and cap.

3. Be sure the bearing inserts and the bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause a failure.

4. Clean the crankshaft journal. When replacing standard bearings with new bearings, fit bearings to the minimum specified clearance with standard bearings.

##### Installation

1. Install the bearing inserts in the connecting rod and cap with the tangs fitted in the slots.

2. Pull the connecting rod assembly down firmly on the crankshaft journal.

3. Select fit the bearings for proper clearance following procedures under Fitting Main and Connecting Rod Bearings in Part 21-01.

4. After the bearing has been fitted, clean and apply a light coat of engine oil to the journal and bearings. Install the connecting rod cap and torque the nuts to specifications.

5. Repeat the procedure for the remaining connecting rods that require new bearings.

6. Install the oil pan and oil pump, following the procedures under Oil Pan Installation.

7. Fill the crankcase and cooling system. Start the engine and check for oil pressure. Operate the engine at fast idle and check for oil and coolant leaks.

#### PISTONS AND CONNECTING RODS

##### REMOVAL

1. Drain the cooling system and the crankcase.

2. Refer to Cylinder Head Removal and remove the cylinder head and related parts.

3. Remove the oil pan following the procedure under Oil Pan Removal. Remove the oil pump inlet tube and the oil pump.

4. Turn the crankshaft until the piston to be removed is at the bottom of its travel and place a cloth on the piston head to collect the cuttings. Remove any ridge and/or deposits from the upper end of the cylinder bore with a ridge cutter. Follow the instructions furnished by the tool manufacturer. **Never cut into the ring travel area in excess of 1/32 inch when removing ridges.**

5. Make sure all the connecting rod caps are marked so that they can be installed in the original locations. Remove the connecting rod cap.

6. Push the connecting rod and piston assembly out the top of the cylinder with the handle end of a hammer. Avoid damage to the crankshaft journal or the cylinder wall when removing the piston and rod.

##### INSTALLATION

1. Clean the oil pump inlet tube screen and the oil pan and block gasket surfaces.

2. Oil the piston rings, pistons and cylinder walls with light engine oil.

3. Be sure to install the pistons in the same cylinders from which they were removed, or to which they were fitted. The connecting rods and bearing caps are numbered from 1 to 6 beginning at the front of the engine. The numbers on the connecting rods

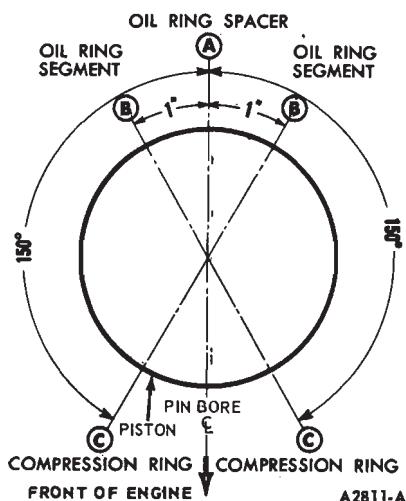


FIG. 31—Piston Ring Spacing

and bearings caps must be on the same side when installed in the cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and the connecting rod should be numbered to correspond with the new cylinder number.

4. Make sure the ring gaps are properly spaced around the circumference of the piston (Fig. 31). Apply engine oil to the piston rings. Install a piston ring compressor on the piston and push the piston in with a hammer handle until it is slightly below the top of the cylinder (Fig. 32). Be sure to guide the connecting rods to avoid damaging the crankshaft journals. **Install the piston with the indentation in the piston head toward the front of the engine.**

5. Check the clearance of each bearing following the procedure under Connecting Rod Bearing Replacement.

6. After the bearings have been fitted, apply a light coat of engine oil to the journals and bearings.

7. Turn the crankshaft throw to the bottom of the stroke, then push the piston all the way down until the connecting rod bearing seats on the crankshaft journal. Install the connecting rod cap. Torque the nuts to specifications.

8. After the piston and connecting rod assemblies have been installed, check the connecting rod side clearance on each crankshaft journal (Fig. 33).

9. Prime and install the oil pump. Install the oil pan and oil pump inlet tube following the procedure under, Oil Pan Installation.

10. Refer to Cylinder Head Installation and install the cylinder head

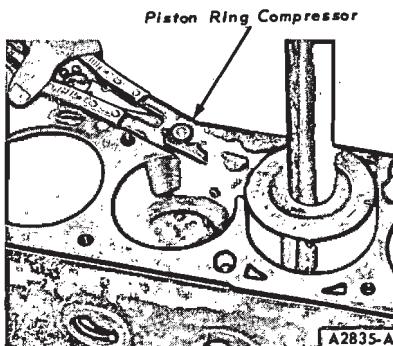


FIG. 32—Installing Piston

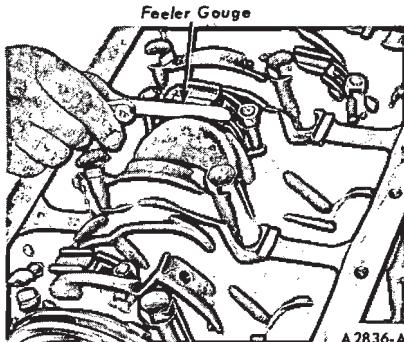


FIG. 33—Checking Connecting Rod Side Clearance

and related parts. Adjust the valve clearance, refer to Part 21-01, Section 2.

11. Fill and bleed the cooling system. Fill the crankcase.

12. Start the engine and check for oil pressure. Operate the engine at fast idle and check for oil and coolant leaks.

13. Operate the engine until engine temperatures have stabilized. Check and adjust the ignition timing. Adjust the engine idle speed and fuel mixture.

## DISASSEMBLY

1. Remove the bearing inserts from the connecting rod and cap.

2. Mark the pistons and pins to assure assembly with the same rod and installation in the same cylinders from which they were removed.

3. Remove the piston rings. Remove the piston pin from the piston and connecting rod using the tool shown in Fig. 34.

## ASSEMBLY

The piston, connecting rod and related parts are shown in Fig. 35.

**Check the fit of a new piston in the cylinder bore before assembling the**

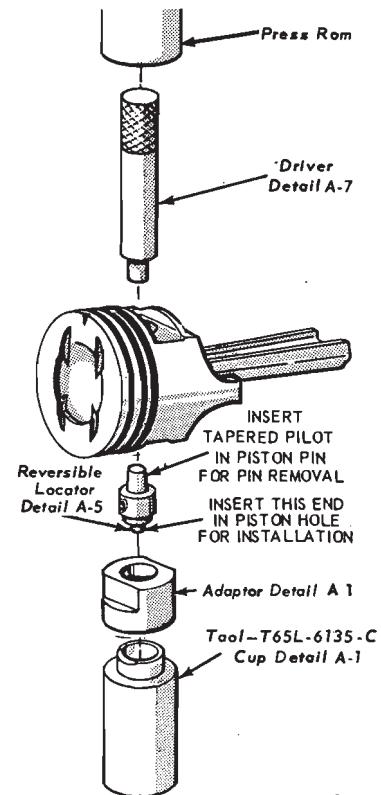


FIG. 34—Piston Pin Removal and Installation—Typical

piston and piston pin to the connecting rod, following the procedures in Part 21-01, Sections 2 and 3.

The piston pin bore of a connecting rod and the diameter of the piston pin must be within specifications.

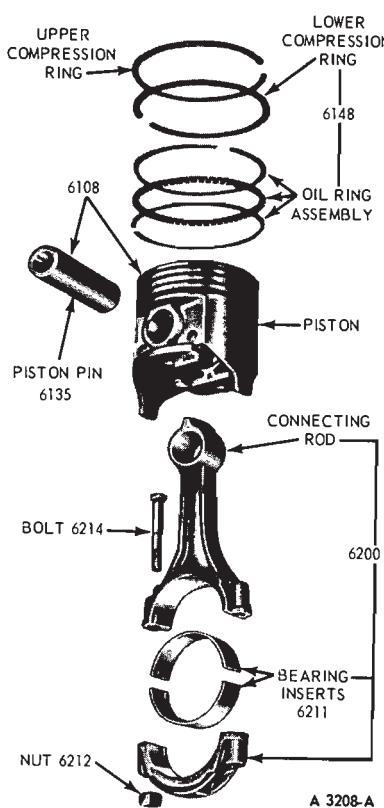
1. Apply a light coat of engine oil to all parts. **Assemble the piston to the connecting rod with the bearing tang notches in the connecting rod (at the parting line of the cap) and the indentation notch in the piston positioned as shown in Fig. 36.**

2. Start the piston pin in the piston and connecting rod (This may require a very light tap with a mallet). Press the piston pin through the piston and connecting rod until the pin is centered in the piston (Fig. 34).

3. Check the end gap of all piston rings (Part 21-01). They must be within specifications.

4. Follow the instructions contained on the piston ring package and install the piston rings.

5. Check the ring side clearance of the compression rings with a feeler gauge inserted between the ring and the lower land (Part 21-01, Section 2). The gauge should slide freely around the entire ring circumference without binding. Any wear that occurs will form a step at the inner por-



**FIG. 35—Typical Piston, Connecting Rod and Related Parts**

tion of the lower land. If the lower lands have high steps, the piston should be replaced.

6. Be sure the bearing inserts and the bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause a failure. Install the bearing inserts in the connecting rod and cap with the tangs fitting in the slots provided.

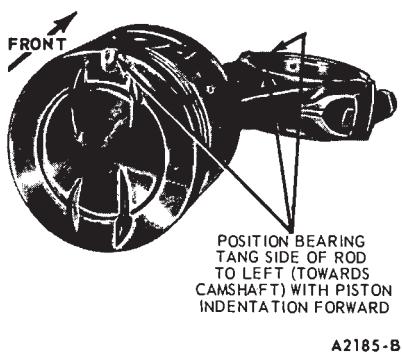
#### FLYWHEEL

##### REMOVAL

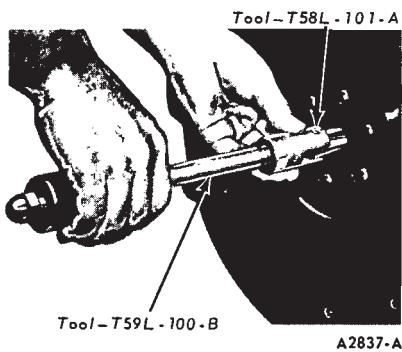
1. On an automatic transmission vehicle, remove the transmission, remove the transmission fluid level dipstick and tube. Dispose of the fluid drained at dipstick tube opening.

Disconnect the transmission shift linkage and drive shaft. Support the transmission on a transmission jack. Disconnect the transmission at the engine and at the support insulator. Move the transmission and converter (automatic transmission) to one side, leaving it on the transmission jack. **Do not drain the converter.**

2. On a manual shift transmission vehicle, remove the clutch pressure



**FIG. 36—Piston and Connecting Rod Assembly**



**FIG. 37—Removing Clutch Pilot Bushing**

plate and cover assembly following the procedure in Group 16.

3. Remove the flywheel attaching bolts and remove the flywheel.

If the flywheel is to be used again refer to Part 21-01, Section 3 for the cleaning and inspection procedures for manual-shift transmissions.

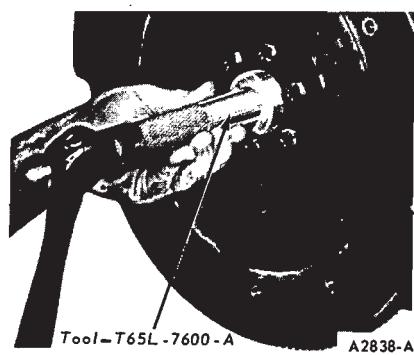
To check flywheel face runout or replace flywheel ring gear for manual shift transmissions, refer to Part 21-01, Section 2.

##### INSTALLATION

1. Position the flywheel on the crankshaft flange. Coat the threads of the flywheel attaching bolts with oil-resistant sealer, and install the bolts. Torque the bolts in sequence across from each other to specifications.

2. On a manual-shift transmission vehicle, install the clutch disc and the pressure plate and cover assembly following the procedure in Group 16.

3. Install the transmission. Torque all attaching bolts to specifications. Connect the driveshaft and transmission shift linkage. Remove the transmission jack. Install the fluid level dipstick and tube (if so equipped). Add transmission fluid as necessary.



**FIG. 38—Installing Clutch Pilot Bearing**

#### CLUTCH PILOT BUSHING REPLACEMENT

Inspection procedures are outlined under Crankshaft Cleaning and Inspection in Part 21-01, Section 3.

##### REMOVAL

1. Disconnect the transmission from the engine and slide it to the rear following the procedure in Group 5.

2. Remove the pressure plate and cover assembly following the procedure in Group 16.

3. Remove the clutch pilot bushing (Fig. 37).

##### INSTALLATION

1. Coat the clutch pilot bushing bore in the crankshaft with a small quantity of wheel bearing lubricant. Avoid using too much lubricant because it may be thrown onto the disc when the clutch revolves.

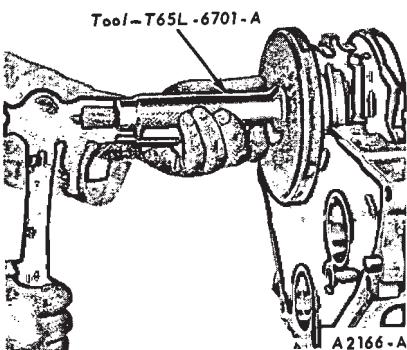
2. Install the clutch pilot service bearing (Fig. 38).

3. Install the clutch disc and the pressure plate and cover assembly following the procedure in Group 16.

4. Connect the transmission to the engine following the procedure in Group 16, except it is not necessary to adjust the transmission linkage.

#### CRANKSHAFT REAR OIL SEAL

If the crankshaft rear oil seal replacement is the only operation being performed, it can be done in the vehicle according to the following procedure. If the oil seal is being replaced in conjunction with a rear main bearing replacement, the engine must be removed from the vehicle and installed on a work stand.



**FIG. 39—Installing Crankshaft Rear Oil Seal**

#### REMOVAL

1. Remove the starter.

2. On an automatic transmission remove the transmission fluid level dipstick and tube. Dispose of the fluid drained at the dipstick tube opening.

Disconnect the transmission shift linkage and drive shaft. Support the transmission on a transmission jack. Disconnect the transmission at the engine and at the support insulator. Move the transmission and converter (automatic transmission) to one side, leaving it on the transmission jack. **Do not drain the converter.**

3. On a manual-shift transmission, remove the pressure plate and cover assembly following the procedure in Group 16.

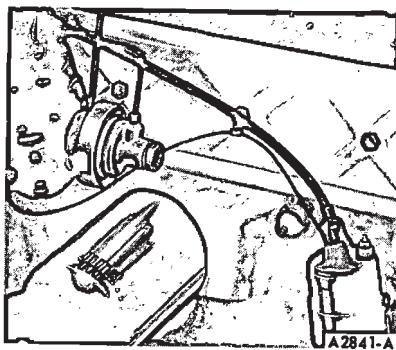
4. Remove the flywheel attaching bolts and remove the flywheel and engine rear cover plate.

5. Use an awl to punch two holes in the crankshaft rear oil seal. Punch the holes on opposite sides of the crankshaft and just above the bearing cap to cylinder block split line. Install a sheet metal screw in each hole. Use two large screwdrivers or small pry bars and pry against both screws at the same time to remove the crankshaft rear oil seal. It may be necessary to place small blocks of wood against the cylinder block to provide a fulcrum point for the pry bars. **Use caution throughout this procedure to avoid scratching or otherwise damaging the crankshaft oil seal surface.**

6. Clean the oil seal recess in the cylinder block and main bearing cap. **Inspect and clean the oil seal contact surface on the crankshaft, following the procedure in Part 21-01.**

#### INSTALLATION

1. Coat the oil seal to cylinder block surface of the oil seal with oil. Coat the seal contact surface of the



**FIG. 40—Oil Filter Installed**

oil seal and crankshaft with Lubriplate. Start the seal in the recess and install it with the tool as shown in Fig. 39. Keep the tool straight with the centerline of the crankshaft, and install the seal until it is flush to 0.005 inch below the face of the cylinder block. **Remove the tool and inspect the seal to be sure it was not damaged during installation.**

2. Install the engine rear cover plate. Position the flywheel on the crankshaft flange. Coat the threads of the flywheel attaching bolts with oil-resistant sealer, and install the bolts. Torque the bolts in sequence across from each other to specifications.

3. On a manual-shift transmission, install the clutch disc and the pressure plate and cover assembly following the procedure in Group 16.

4. Install the transmission. Torque all attaching bolts to specifications. Connect the driveshaft and transmission shift linkage. Remove the transmission jack. Install the fluid level dipstick and tube (if so equipped). Add transmission fluid as necessary.

5. Install the starter.

#### OIL FILTER

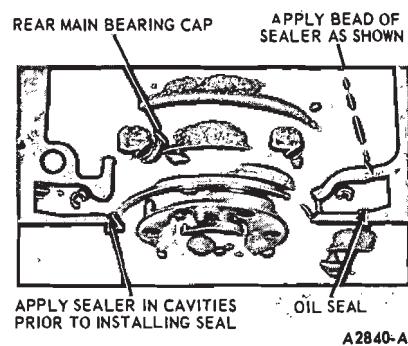
##### REMOVAL

1. Place a drip pan under the oil filter. Unscrew the filter from the cylinder block with a filter wrench.

##### INSTALLATION

1. Coat the gasket on the filter with oil. Place the filter in position on the cylinder block (Fig. 40). Hand tighten the filter until the gasket contacts the adapter face; then advance it 1/2 turn.

2. Operate the engine at fast idle, and check for oil leaks. If oil leaks are evident, perform the necessary repairs to correct the leakage. Check



**FIG. 41—Oil Pan Rear Seal Installation**

the oil level and fill the crankcase if necessary.

#### OIL PAN AND OIL PUMP

##### REMOVAL

1. Drain the crankcase and the cooling system.

2. Disconnect the radiator upper hose at the coolant outlet elbow and the lower hose at the radiator. Disconnect the automatic transmission fluid cooler lines at the radiator (if so equipped). Remove the radiator.

On a vehicle with air conditioning, remove the condenser attaching bolts, and position the condenser to one side for accessibility. **Do not disconnect the condenser refrigerant lines.**

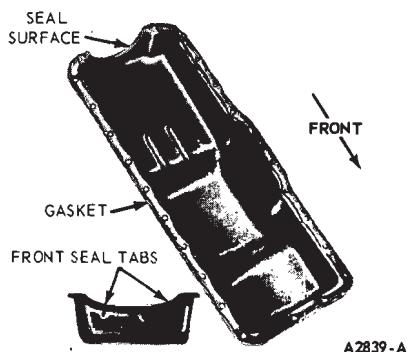
3. Raise the vehicle on a hoist.

4. Disconnect the starter cable at the starter. Remove the attaching bolts and remove the starter.

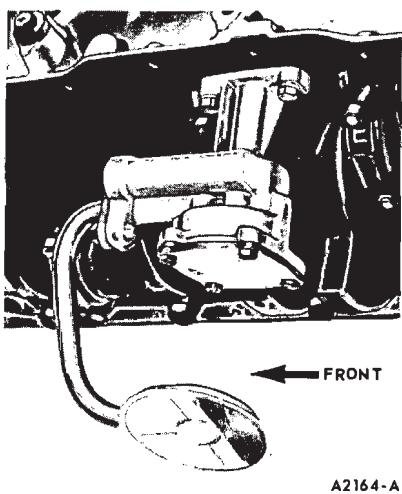
5. Remove the engine front support insulator to intermediate support bracket nuts on both supports. Remove the engine rear support insulator to crossmember bolt and insulator to transmission extension housing bolts. Raise the transmission, remove the support insulator, and lower the transmission to the crossmember.

6. Raise the engine with a transmission jack and place 3-inch thick wood blocks between both front support insulators and intermediate support brackets. Remove the stabilizer bar.

7. Remove the oil pan attaching bolts. Allowing the pan to rest on the crossmember remove the oil pump attaching bolts. Remove the oil pump from the cylinder block and place it in the bottom of the oil pan. Rotate the crankshaft as required to remove the oil pan; then remove the oil pan and gaskets. Remove the inlet tube and screen from the oil pump.



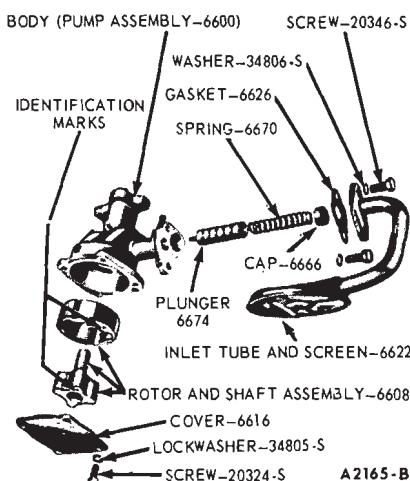
**FIG. 42—Oil Pan Gaskets and Front Seal Installed**



**FIG. 43—Oil Pump Installed**

### INSTALLATION

- Clean the inlet tube and screen assembly and install it on the oil pump using a new gasket.
- Clean the gasket surfaces of the oil pump, oil pan and cylinder block. Remove the rear main bearing cap to oil pan seal and cylinder front cover to oil pan seal. Clean the seal grooves.
- Apply oil-resistant sealer in the cavities between the bearing cap and cylinder block (Fig. 41). Install a new seal in the rear main bearing cap, and



**FIG. 44—Oil Pump Assembly**

apply a bead of oil-resistant sealer to the tapered ends of the seal (Fig. 41).

- Install new side gaskets on the oil pan with oil-resistant sealer (Fig. 42). Position a new cylinder front cover seal on the oil pan.

5. Prime the oil pump. Place the oil pump and inlet tube assembly in the oil pan. Position the oil pan under the engine. Install the oil pump with a new gasket on the cylinder block. The correct installation of the oil pump is shown in Fig. 43. Torque the screws to specifications. Position the oil pan against the cylinder block and install the retaining screws. Torque the screws in sequence to specifications.

6. Raise the engine and remove the wood blocks from the engine front supports. Lower the engine until the front support insulators are positioned on the intermediate support brackets.

7. Raise the transmission and install the rear support insulator on the transmission extension housing. Torque the bolts to specifications. Lower the transmission and install the rear support insulator to crossmember bolt and nut. Torque the nut to specifications. Install and torque the front support insulator nuts to specification.

- Install the starter and connect the starter cable.

9. On a vehicle with air conditioning, position the condenser and install the attaching bolts.

10. Install the radiator and connect the radiator upper and lower hoses. Connect the automatic transmission fluid cooler lines (if so equipped).

11. Fill the crankcase and cooling system.

12. Start the engine and check for coolant and oil leaks.

### OIL PUMP DISASSEMBLY

- Remove the oil inlet tube from the oil pump. Remove and discard the gasket.

2. Remove the cover attaching screws and remove the cover. Remove the inner rotor and shaft assembly; then remove the outer race.

3. Scrape away the staking marks in the body around the oil pressure relief valve cap. Drill a 1/8-inch hole in the relief valve cap, and insert a self-threading sheet metal screw of proper diameter into the cap. Pull the cap out of the chamber. Remove the spring and plunger.

### OIL PUMP ASSEMBLY

The oil pump assembly is shown in Fig. 44.

- Clean all parts thoroughly. Install the oil pressure relief valve plunger, spring and a new cap. Stake the cap into position.

2. Install the outer race (recessed dot facing out—on same side as dot on rotor) and the inner rotor and shaft assembly. The **inner rotor and shaft and the outer race are serviced as an assembly. One part should not be replaced without replacing the other.** Install the cover and torque the retaining screws to specifications.

3. Position a new oil inlet tube gasket on the oil pump and install the inlet tube. Prime the oil pump with engine oil before installing it on the engine.

## 3 ENGINE REMOVAL AND INSTALLATION

The engine removal and installation procedures are for the engine only without the transmission attached.

### REMOVAL

- Drain the cooling system and the crankcase. Remove the hood. Re-

move the air cleaner.

- Disconnect the battery positive cable. Disconnect the heater hoses from the water pump and coolant

outlet housing. Disconnect the flexible fuel line from the fuel tank line.

**3.** Disconnect the radiator upper hose at the coolant outlet housing, and disconnect the radiator lower hose from the water pump.

On a vehicle with an automatic transmission, disconnect the transmission fluid cooler lines from the radiator.

**4.** Remove the radiator. Remove the cooling fan, spacer, water pump pulley and fan drive belt.

**5.** Disconnect the accelerator cable at the carburetor. Remove the cable retracting spring. Remove the cable housing bracket from the cylinder head, and position the cable and bracket assembly out of the way.

On a vehicle with power brakes, disconnect the vacuum line at the intake manifold.

On a vehicle with an automatic transmission, disconnect the transmission kickdown rod at the bellcrank assembly.

On a vehicle with air conditioning, remove the compressor from the mounting bracket, and position it out of the way, leaving the refrigerant lines connected.

**6.** Disconnect the exhaust manifold from the muffler inlet pipe. Disconnect the body ground strap and the battery ground cable at the engine.

**7.** Disconnect the engine wiring harness at the ignition coil, coolant temperature sending unit and oil pressure sending unit. Position the harness out of the way.

**8.** Remove the alternator mounting bolts and position the alternator out of the way, leaving the wires attached.

On a vehicle with power steering, remove the power steering pump from the mounting brackets and position it to the side, leaving the lines attached.

**9.** Raise the vehicle. Remove the starter (and the automatic transmission fluid filler tube bracket). Remove the engine rear plate upper right bolt.

On a vehicle with a manual-shift transmission, remove all the flywheel housing lower attaching bolts.

On a vehicle with an automatic transmission, remove the converter housing access cover assembly. Remove the flywheel to converter nuts; then secure the converter assembly in the housing. Remove the transmission fluid cooler lines from the retaining clip at the engine. Remove the converter housing to engine lower attaching bolts.

**10.** Remove the insulator to intermediate support bracket nut from each engine front support.

**11.** Lower the vehicle and position a transmission jack under the transmission to support it. Remove the remaining flywheel or converter housing to engine bolts.

**12.** Attach the engine lifting hook (Fig. 45). Remove two bolts attaching the right side engine support insulator to the engine. Remove the insulator. Raise the engine slightly; then carefully pull it from the transmission. Lift the engine out of the chassis.

## INSTALLATION

**1.** Place a new gasket on the muffler inlet pipe.

**2.** Lower the engine carefully into the chassis. Make sure the studs on the exhaust manifold are aligned with the holes in the muffler inlet pipe and the dowels in the block engage the holes in the flywheel or converter housing.

On a vehicle with an automatic transmission, start the converter pilot into the crankshaft. Remove the retainer securing the converter in the housing.

On a vehicle with a manual-shift transmission, start the transmission main drive gear into the clutch disc. It may be necessary to adjust the position of the transmission with relation to the engine if the transmission input shaft will not enter the clutch disc. If the engine hangs up after the shaft enters, turn the crankshaft slowly (with the transmission in gear) until the shaft splines mesh with the clutch disc splines.

**3.** Install the converter or flywheel housing upper attaching bolts. Remove the jack supporting the transmission.

**4.** Install the engine front support insulator on the right side of the engine. Install the insulator to engine bolts and torque to specifications. Lower the engine until it rests on the engine supports and remove the lifting hook.

**5.** Raise the vehicle and install the engine left and right support insulator to intermediate support bracket retaining nuts. Torque the nuts to specifications. Install the automatic transmission fluid cooler lines bracket.

**6.** Install the remaining converter or flywheel housing attaching bolts.

**7.** Install the starter and connect the starter cable, and attach the automatic transmission fluid filler tube bracket (if so equipped).

On a vehicle with an automatic transmission, install the transmission

fluid cooler lines in the bracket at the engine block.

**8.** Install the exhaust manifold to muffler inlet pipe lock washers and nuts. Torque the nuts to specifications.

**9.** Lower the vehicle. Connect the engine ground strap and the battery ground cable.

**10.** On a vehicle with an automatic transmission, connect the kickdown rod to the bellcrank assembly on the intake manifold.

Install the accelerator cable housing bracket on the cylinder head. Connect the cable to the carburetor and install the retracting spring.

On a vehicle with power brakes, connect the brake vacuum line to the intake manifold.

**11.** Connect the coil primary wire, oil pressure and coolant temperature sending unit wires, flexible fuel line, heater hoses, and the battery positive cable.

**12.** Install the alternator on the mounting bracket.

On a vehicle with power steering, install the power steering pump on the mounting brackets.

On a vehicle with air conditioning, install the compressor on the mounting bracket, and adjust the belt tension to specifications.

**13.** Install the water pump pulley, spacer, cooling fan and drive belt. Torque the fan bolts to specifications.

Adjust the fan drive belt and power steering pump drive belt (if so equipped) tension to specifications. Tighten the alternator and power steering pump mounting bolts.

**14.** Install the radiator. Connect the radiator lower hose to the water pump and the radiator upper hose to

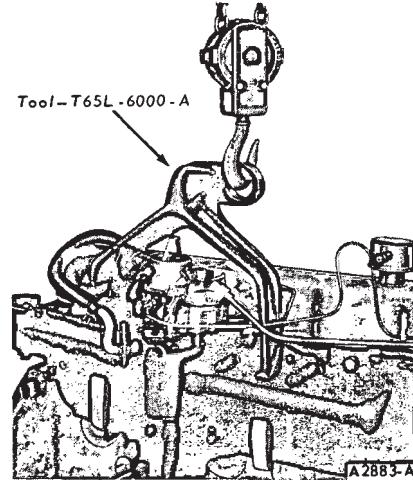


FIG. 45—Removing or Installing Engine

the coolant outlet housing.

On a vehicle with an automatic transmission, connect the oil cooler lines.

15. Install and adjust the hood.
16. Fill and bleed the cooling

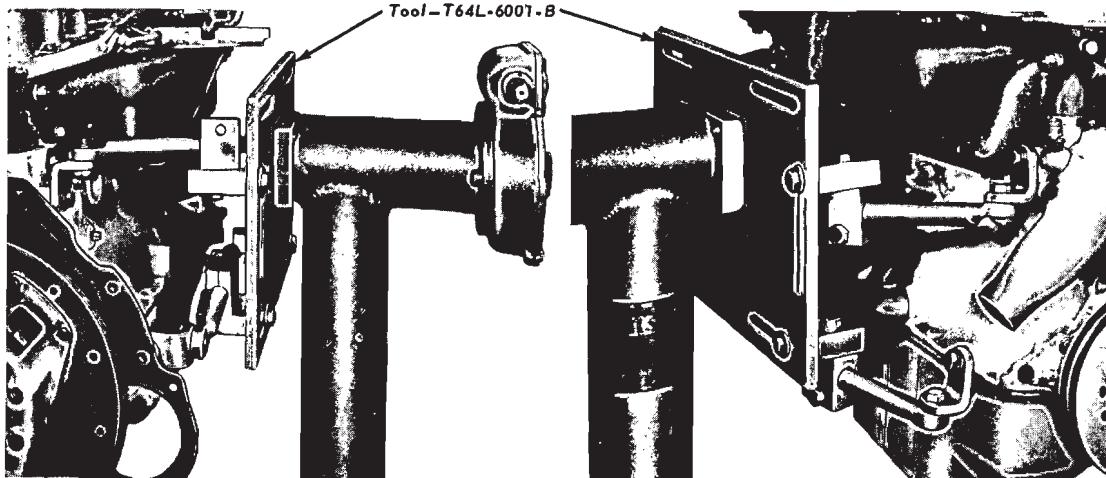
system. Fill the crankcase. Operate the engine at fast idle and check all hose connections and gaskets for leaks.

17. Adjust the carburetor idle speed and mixture.

On a vehicle with standard transmission, adjust the clutch pedal free-travel. On a vehicle with an automatic transmission, adjust the transmission control linkage.

18. Install the air cleaner.

## 4 MAJOR REPAIR OPERATIONS



A2842-A

**FIG. 46—Engine Mounted on Work Stand—Typical**

To perform the operations in this section, it will be necessary to remove the engine from the vehicle and install it on a work stand as shown in Fig. 46. For engine removal and installation procedures, refer to Section 3.

When installing nuts or bolts that must be torqued (refer to Part 8-8 for torque specifications), oil the threads with light weight engine oil. **Do not** oil threads that require oil-resistant or water-resistant sealer.

### MAIN BEARING REPLACEMENT

1. Remove the engine from the vehicle, following the procedure in Section 3, and install it on a work stand.

2. On vehicles equipped with standard transmission, remove the clutch disc and pressure plate.

Remove the flywheel and engine rear cover plate.

3. Turn the engine on the work stand so that the bottom of the engine is up. Remove the oil pan, gaskets and seals. Remove the oil pump and inlet tube assembly. Discard the oil pump gasket.

4. Remove the main bearing caps, and remove the bearings from the

caps.

5. Remove the crankshaft rear oil seal and discard it.

6. Insert the upper bearing removal tool (tool 6331) in the oil hole in one of the crankshaft journals.

7. Rotate the crankshaft in the direction of engine rotation to force the bearing out of the block.

8. Clean the crankshaft journals. Inspect the journals and thrust faces (thrust bearing) for nicks, burrs or bearing pick-up that would cause premature bearing wear. **When replacing standard bearings with new bearings, first try to obtain the proper clearance with two blue bearing halves.**

9. The upper and lower bearing halves are not interchangeable. The upper half is identifiable by the oil hole and groove. To install the upper main bearing, place the plain end of the bearing over the shaft on the locking tang side of the block and partially install the bearing so that tool 6331 can be inserted in the oil hole in the crankshaft. With tool 6331 positioned in the oil hole in the crankshaft, rotate the crankshaft in the opposite direction of engine rotation until the bearing is seated. Remove the tool.

10. Install the remaining main bearing upper halves.

11. Clean the bearing caps and install the main bearing lower halves in the caps.

12. Select fit the bearings for proper clearance following procedures under Fitting Main and Connecting Rod Bearings in Part 21-01.

13. After the bearing has been fitted, apply a light coat of engine oil to the journal and bearings, then install the bearing cap. Torque the cap bolts to specifications.

14. Repeat the procedure for the remaining bearings.

15. If the thrust bearing cap (No. 5 main bearing) has been removed, install it as follows:

Install the thrust bearing cap with the bolts finger-right. Pry the crankshaft forward against the thrust surface of the upper half of the bearing (Fig. 45). Hold the crankshaft forward and pry the thrust bearing cap to the rear. This will align the thrust surfaces of both halves of the bearing. Retain the forward pressure on the crankshaft. Torque the cap bolts to specifications.

16. If the rear main bearing is replaced (on a work stand), be sure the

main bearing is fitted and the cap bolts torqued to specifications; then install the new crankshaft rear oil seal.

17. Clean the oil pan, oil pump and oil pump screen.

18. Install the inlet tube and screen on the oil pump. Prime the oil pump with engine oil and install it with a new gasket. Torque the attaching bolts to specifications.

19. Apply oil-resistant sealer in the cavities between the bearing cap and cylinder block (Fig. 39). Install a new oil pan rear seal in the rear main bearing cap and apply a bead of oil-resistant sealer to the tapered ends of the seal. Install new side gaskets on the oil pan with oil-resistant sealer (Fig. 40). Position a new cylinder front cover seal on the oil pan.

20. Turn the engine on the work stand so that the rear of the engine is

up. Position the engine rear cover plate on the cylinder block. Position the flywheel on the crankshaft. Coat the threads of the attaching bolts with oil-resistant sealer and install the bolts. Torque the bolts to specifications.

On a flywheel for a manual-shift transmission, locate the clutch disc following the procedure in Group 16. Install the pressure plate. Torque the retaining bolts to specifications.

21. Fill the crankcase and cooling system. Start the engine and check for oil pressure. Operate the engine at fast idle and check for oil and coolant leaks.

### CRANKSHAFT

The crankshaft and related parts are shown in Fig. 48.

### REMOVAL

1. Install the engine on a work stand. Remove the spark plugs to allow easy rotation of the crankshaft.

2. Remove the oil level dipstick.

3. Remove the accessory drive pulley (if so equipped). Remove the crankshaft damper attaching screw and lock washer; then remove the crankshaft damper (Fig. 17).

4. Remove the cylinder front cover and air conditioning drive idler pulley assembly (if so equipped). Remove the cover gasket. Remove the oil slinger.

5. Turn the engine on the work stand so that the bottom of the engine is up. Remove the oil pan, gaskets and tube assembly. Discard the oil pump gasket.

6. Make sure all bearing caps (main and connecting rod) are

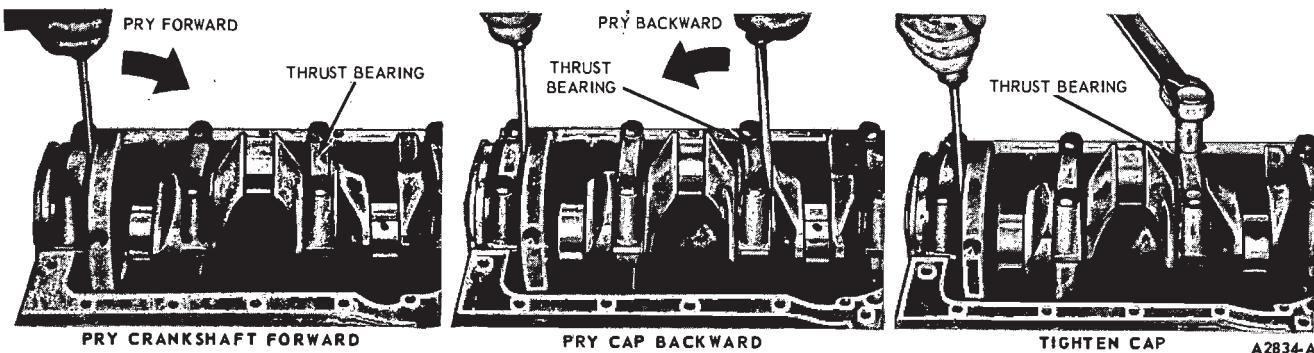


FIG. 47—Aligning Thrust Bearing

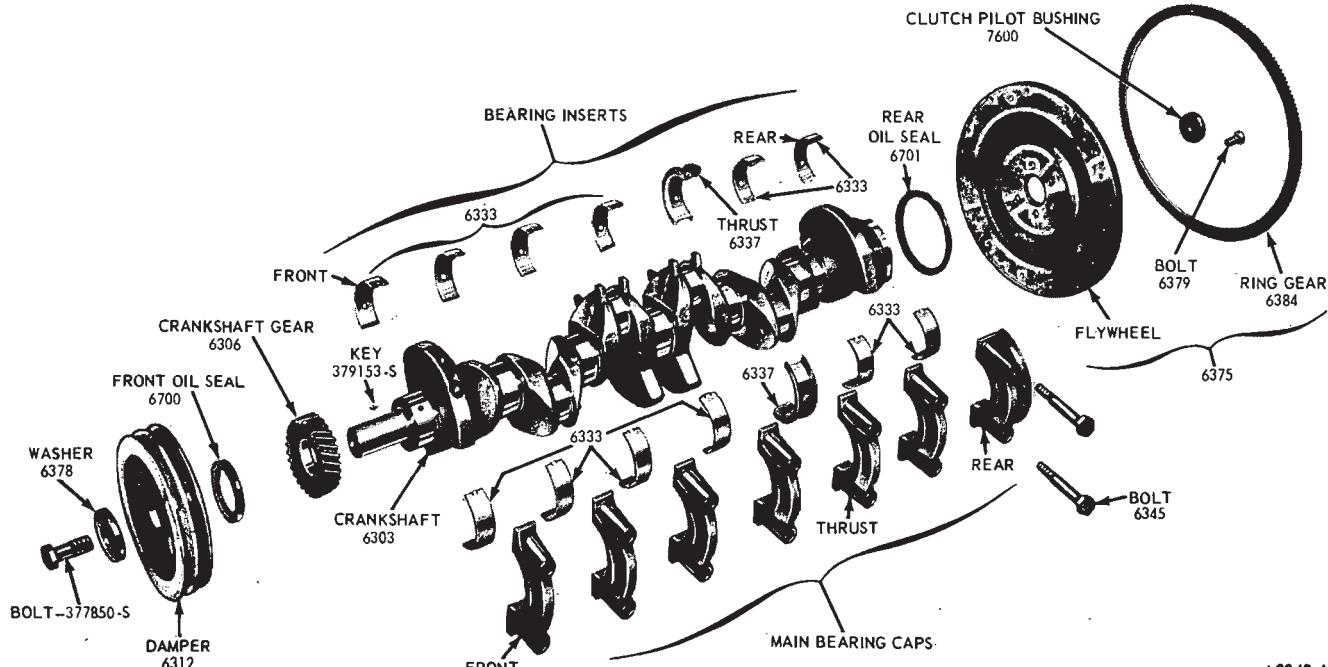


FIG. 48—Crankshaft and Related Parts

A2843-A

**marked so that they can be installed in their original locations.** Turn the crankshaft until the connecting rod from which the cap is being removed is at the bottom of the stroke. Remove the connecting rod cap and bearings. Push the connecting rod and piston assembly up in the cylinder. **Do not turn the crankshaft completely around as the rod bolts may damage the crankpin journals.** Repeat this procedure and remove all connecting rod caps.

7. Remove the clutch pilot bushing, if necessary (Fig. 37).

8. Align the timing marks (Fig. 26). Remove the crankshaft gear (Fig. 21).

9. Remove the flywheel and engine rear cover plate.

10. Remove the main bearing caps and bearings. Remove the crankshaft rear oil seal.

11. Carefully lift the crankshaft out of the cylinder block so that the thrust bearing surfaces are not damaged.

**Handle the crankshaft with care to avoid possible fracture or damage to the finished surfaces.**

**Be sure the oil seal surfaces on the crankshaft and crankshaft damper are properly cleaned.**

## INSTALLATION

1. Remove the main bearing inserts from the block and bearing caps.

2. Remove the bearing inserts from the connecting rod caps.

3. Clean the crankshaft rear oil seal recess in the cylinder block and rear main bearing cap.

4. If the crankshaft main bearing journals have been refinished to a definite undersize, install the correct undersize bearings. Be sure the bearing inserts and bearing bores are clean. Foreign material under the inserts will distort the bearing and cause a failure.

5. Place the upper main bearing inserts in position in the bore with the tang fitting in the slot provided. Be sure the oil holes in the bearing inserts are aligned with the oil holes in the cylinder block transverse webs.

6. Install the lower main bearing inserts in the bearing caps with the tang fitted in the slot.

7. Carefully lower the crankshaft into place. **Be careful not to damage the bearing surfaces.**

8. Select fit the bearings for proper clearance following procedures under Fitting Main and Connecting Rod Bearings in Part 21-01.

9. After the bearings have been fitted, apply a light coat of engine oil to the journals and bearings. Install all the bearing caps, except the thrust bearing cap (No. 5 bearing). **Be sure that the main bearing caps are installed in the original locations.** Torque the bearing cap bolts to specifications.

10. Install the thrust bearing cap with the bolts finger-tight.

11. Pry the crankshaft forward against the thrust surface of the upper half of the bearing (Fig. 47).

12. Hold the crankshaft forward and pry the thrust bearing cap to the rear (Fig. 47). This will align the thrust surfaces of both halves of the bearing.

13. Retain the forward pressure on the crankshaft. Torque the cap bolts to specifications (Fig. 47).

14. Check the crankshaft end play, following the procedure in Part 21-01, Section 1.

15. If the end play exceeds specifications, replace the thrust bearing. If the end play is less than the minimum limit, inspect the thrust bearing faces for scratches, burrs, nicks or foreign matter. If the thrust faces are not damaged, they probably are not aligned properly. Install the thrust bearing and align the faces following the recommended procedure (Steps 10 thru 13); then check the end play.

16. Coat the oil seal to cylinder block surface of the oil seal with oil. Coat the seal contact surface of the oil seal and crankshaft with Lubriplate. Install the seal with the tool shown in Fig. 39. Inspect the seal to be sure it was not damaged during installation.

17. Install the bearing inserts in the connecting rods and caps. Check the clearance of each bearing following the procedure under Fitting Main and Connecting Rod Bearings in Part 21-01.

18. If the bearing clearances are to specifications, apply a light coat of engine oil to the journals and bearings.

19. Turn the crankshaft throw to the bottom of its stroke, and pull the piston all the way down until the connecting rod bearing seats on the crankshaft journal.

20. Install the connecting rod cap and torque the nuts to specifications.

21. After the piston and connecting rod assemblies have been installed, check the connecting rod side clearance on each crankshaft journal (Fig. 33).

22. Clean the oil pan, oil pump

and oil pump screen.

23. Install the inlet tube and screen on the oil pump. Prime the oil pump with engine oil and install it with a new gasket. Torque the attaching bolts to specifications.

24. On a crankshaft for a standard transmission, install the clutch pilot bushing (refer to Clutch Pilot Bushing Replacement).

25. Turn the engine on the work stand so that the rear of the engine is up. Position the engine rear cover plate on the cylinder block. Position the flywheel on the crankshaft. Coat the threads of the attaching bolts with oil-resistant sealer and install the bolts. Torque the bolts to specifications.

On a flywheel for a manual-shift transmission, locate the clutch disc following the procedure in Group 16. Install the pressure plate. Torque the attaching bolts to specifications.

26. Turn the engine on the work stand so that the front end is up.

27. Install the crankshaft gear following the procedure under Timing Gears Installation. Install the oil slinger.

28. Install a new crankshaft front oil seal in the cylinder front cover, (Fig. 18). Install the cylinder front cover and crankshaft damper by following the procedure outlined under Cylinder Front Cover Installation in Part 21-01.

29. Apply oil-resistant sealer in the cavities between the bearing cap and cylinder block (Fig. 41). Install a new oil pan rear seal in the rear main bearing cap and apply a bead of oil-resistant sealer to the tapered ends of the seal (Fig. 41). Install new side gaskets on the oil pan with oil-resistant sealer (Fig. 41). Position a new cylinder front cover seal on the oil pan.

30. Install the oil level dipstick.

31. Remove the engine from the work stand and install it in the vehicle.

32. Check the ignition timing and adjust if necessary.

## CAMSHAFT BEARING REPLACEMENT

Camshaft bearings are available pre-finished to size for standard and 0.015-inch undersize journal diameters.

1. Remove the camshaft and the flywheel.

2. Remove the camshaft rear bearing bore plug. Remove the camshaft bearings with the tool shown in Fig.

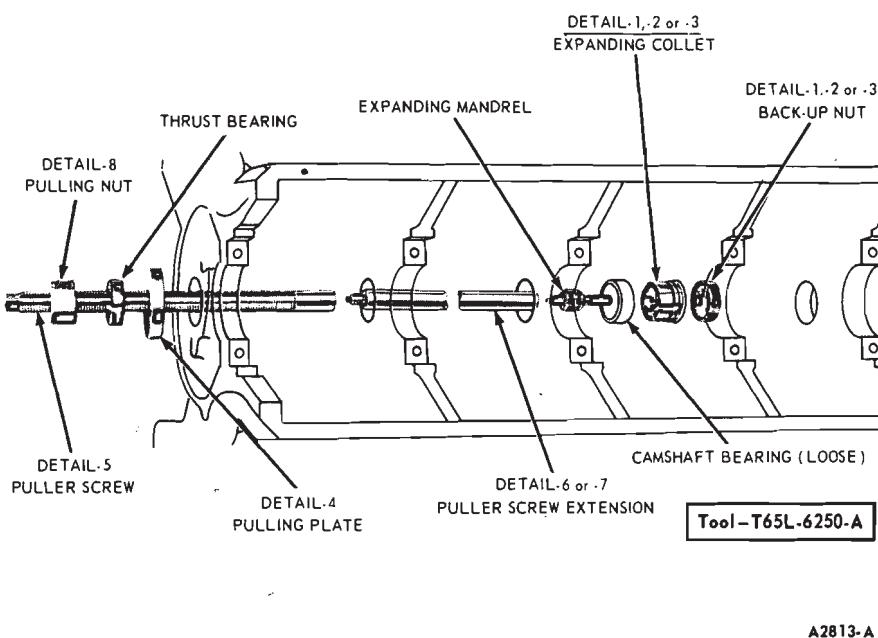


FIG. 48—Replacing Camshaft Bearings

48.

3. Select the proper size expanding collet and back-up nut and assemble on the expanding mandrel. With the expanding collet collapsed, install the collet assembly in the camshaft bearing, and tighten the back-up nut on the expanding mandrel until the collet fits the camshaft bearing.

4. Assemble the puller screw and extension (if necessary) as shown and install on the expanding mandrel. Wrap a cloth around the threads of the puller screw to protect the front bearing or journal. Tighten the pulling nut against the thrust bearing and pulling plate to remove the camshaft bearing. Be sure to hold a wrench on the end of the puller screw to prevent it from turning.

5. Repeat the procedure for each bearing. To remove the front bearing, install the puller screw from the rear of the cylinder block.

6. Position the new bearings at the bearing bores, and press them in place with the tool shown in Fig. 48. Be sure to center the pulling plate and puller screw to avoid damage to the bearing. **Failure to use the correct expanding collet can cause severe bearing damage.** Align the oil holes in the bearings with the oil holes in the cylinder block when the bearings are installed. Be sure the front bearing is installed the specified distance below the front face of the cylinder block.

7. Replace the core plug as detailed in Part 21-01, Section 2.

8. Install the camshaft, flywheel and related parts. Install the engine in the vehicle.

#### CYLINDER ASSEMBLY REPLACEMENT (SHORT BLOCK)

Before replacing any cylinder assembly or cylinder block refer to Part 21-01, Section 2 to determine whether it is repairable. If repairable, follow the given procedures.

#### DISASSEMBLY

Follow steps 1 thru 19 under Engine Disassembly. Remove the cylinder head dowels from the cylinder block. Remove the cylinder block drain plugs and remove the cylinder assembly from the work stand.

#### ASSEMBLY

Install the replacement cylinder assembly on a work stand. Install the cylinder block drain plugs and cylinder head dowels. Transfer all parts removed from the old cylinder assembly, following the procedures under Engine Assembly. Check all assembly clearances and correct as required.

#### CYLINDER BLOCK REPLACEMENT

Before replacing any cylinder block or cylinder assembly refer to Part 21-01, Section 2 to determine whether it is repairable. If repairable, follow the given procedures.

#### DISASSEMBLY

Follow the procedures under Engine Disassembly. Remove the cylinder head dowels and cylinder block drain plugs. Remove the intake and exhaust manifolds and cylinder head as an assembly. Remove the cylinder block from the work stand. Clean the gasket and seal surfaces of all parts and assemblies.

#### ASSEMBLY

Install the replacement cylinder block on a work stand. Install the cylinder block drain plugs and cylinder head dowels. Transfer all parts removed from the old cylinder block to the new cylinder block, following the procedures under Engine Assembly. Install the manifolds and cylinder head as an assembly. Check all assembly clearance and correct as required.

#### ENGINE DISASSEMBLY

1. Remove the engine support insulators from the engine.

2. Install the engine on a work stand (Fig. 46).

3. Disconnect the spark plug wires at the spark plugs. Disconnect the distributor high tension lead at the coil. Remove the distributor cap and spark plug wires as an assembly.

4. Disconnect the fuel line at the carburetor and fuel pump. Disconnect the vacuum line at the distributor and carburetor. Remove the fuel and vacuum lines. Identify the vacuum lines for proper replacement.

5. Remove the fuel pump and discard the gasket.

6. Remove the oil pressure sending unit and the oil level dipstick.

7. Disconnect the distributor primary wire at the coil; then remove the distributor. Remove the ignition coil and bracket assembly. Remove the distributor vacuum advance control valve (deceleration valve).

8. Remove the oil filter and oil filter mounting adapter.

9. Remove the crankcase ventilation regulator valve from the valve rocker arm cover. Remove the rocker arm cover.

10. Loosen the rocker arm stud nuts, rotate the rocker arms to one side, and remove the push rods in sequence. Place the push rods in a rack so they can be installed in the same location from which they were removed.

11. Remove the valve push rod

cover. Remove the valve lifters and place them in a rack so that they can be identified and installed in the bore from which they were removed.

12. Remove the cooling fan, spacer, water pump pulley and fan and alternator drive belts.

13. Remove the alternator mounting bracket and adjusting arm bracket.

If equipped with air conditioning, remove the compressor mounting bracket.

14. Remove the water pump.

15. Remove the carburetor, intake and exhaust manifold and cylinder head as an assembly.

16. Remove the accessory drive pulley (if so equipped). Remove the crankshaft damper (Fig. 17). Remove the cylinder front cover and air conditioning drive idler pulley assembly (if so equipped). Remove the crankshaft front oil seal from the cylinder front cover.

17. Remove the flywheel and engine rear cover plate.

18. Remove the oil pan and oil rear cover plate.

19. Remove the oil pan and oil pump and pick-up tube assembly. Discard the gaskets and seals.

20. Check the camshaft end play with a dial indicator following the procedure in Part 21-01, Section 1. Position the camshaft gear as shown in Fig. 28 and remove the camshaft thrust plate screws. Remove the camshaft, thrust plate and gear as an assembly.

21. Remove the crankshaft gear as shown in Fig. 21.

22. Remove any ridge and/or deposits from the upper end of the cylinder bores. Remove the cylinder ridge with a ridge cutter. Follow the instructions furnished by the tool manufacturer. Never cut into the ring travel area in excess of 1/32 inch when removing ridges.

23. Make sure all bearing caps (main and connecting rod) are marked so that they can be installed in their original locations. Turn the crankshaft until the connecting rod being removed is down. Remove the connecting rod cap.

24. Push each connecting rod and piston assembly out the top of the cylinder with the handle end of a hammer. Avoid damage to the crankshaft journal or the cylinder wall when removing the piston and rod.

25. Remove the bearing inserts from the connecting rods and caps. Install the rod caps on the connecting rods from which they were removed.

26. Remove the main bearing caps. Carefully lift the crankshaft out of the cylinder block so that the thrust bearing surfaces are not damaged. Remove the crankshaft rear oil seal. Handle the crankshaft with care to avoid possible fracture or damage to the finished surfaces.

27. Remove the main bearing inserts from the cylinder block and main bearing caps.

28. Remove the oil dipstick tube from the cylinder block. Remove the cylinder head dowel pins and cylinder block drain plugs.

29. Disassemble the pistons, piston rings and connecting rods, following the procedures under Pistons and Connecting Rods Disassembly (Part 21-01, Section 2).

30. If the camshaft gear is to be removed from the camshaft, press the camshaft out of the gear in an arbor press. Remove the thrust plate and spacer.

31. Drill a hole in the camshaft rear bearing bore plug and remove the plug. Remove the camshaft bearings; refer to Camshaft Bearing Replacement.

32. Remove the carburetor from the intake manifold and discard the gasket. Remove the intake and exhaust manifolds from the cylinder head and separate the manifolds. Disassemble the cylinder head, removing the rocker arms, valves, valve springs, coolant outlet elbow, etc. Place all parts in a rack or identify them so they can be installed in the same location from which they were removed.

## ENGINE ASSEMBLY

- Clean and inspect all parts per the appropriate procedures in Part 21-01, except do not disassemble the oil pump and hydraulic valve lifters for cleaning.

- Remove the glaze from the cylinder bores by following the instructions of the tool manufacturer. Also refer to Part 21-01, Section 2 of this manual.

- Invert the engine on the work stand. Position new camshaft bearings in the bearing bores and press them in place (Fig. 48). Align the oil holes in the cylinder block when the bearings are installed. Be sure the camshaft front bearing is installed below the front face of the cylinder block to specifications.

- Install the core plug as detailed in Part 21-01, Section 2.

- Place the spacer and thrust plate

on the camshaft.

- Install the key in the camshaft. Align the keyway in the gear with the key, then press the gear onto the shaft, making sure that it seats tight against the spacer.

- Check the camshaft end play by inserting a feeler gauge between the thrust plate and gear or the front bearing journal of the camshaft. This clearance will determine the camshaft end play. If not within specifications, replace the thrust plate.

- Oil the camshaft journals and apply Lubriplate to all the lobes. Carefully slide the camshaft through the bearings making sure the timing marks are in alignment when the gears are engaged. Install and torque the thrust plate attaching screws.

- If the crankshaft main bearing journals have been refinished to a definite undersize, install the correct undersize bearings. Be sure the bearing inserts and bearing bores are clean.

- Place the upper main bearing inserts in position in the bore with the tang fitting in the slot provided.

- Install the lower main bearing inserts in the bearing caps.

- Carefully lower the crankshaft into place. Be careful not to damage the bearing surfaces.

- Check the clearance of each main bearing following the procedure under Main Bearing Replacement.

- After the bearings have been fitted, apply a light coat of engine oil to the journals and bearings. Install all the bearing caps, except the thrust bearing cap (No. 5 bearing). Be sure that the main bearing caps are installed in the original locations. Torque the bearing cap bolts to specifications.

- Install the thrust bearing cap and check the crankshaft end play by following the procedure under Crankshaft Installation.

- Check the camshaft gear backlash following the procedures in Part 21-01, Section 1. If the gear backlash exceeds specifications, replace the camshaft gear (and crankshaft gear as necessary).

- Check the camshaft gear runout with a dial indicator (Part 21-01, Section 1). If the gear runout is excessive, remove the gear and clean any burrs from the shaft, or replace the gear.

- Check the piston to cylinder bore fit of each piston, following the procedure in Part 21-01, Section 3.

- Check the end gap of all piston rings (Part 21-01, Section 3). Assemble the pistons, piston rings and

connecting rods, following the procedure under Pistons and Connecting Rods Assembly (Part 21-01, Section 2). Check the piston ring side clearance (Part 21-01, Section 3).

20. Install the piston and connecting rod assemblies, and check the clearance of the connecting rod bearings. Refer to Piston and Connecting Rod Installation and Connecting Rod Bearing Replacement (Part 21-01, Section 2).

21. Coat a new crankshaft front oil seal with grease and install it in the cylinder front cover (Fig. 18).

22. Coat the gasket surfaces of the cylinder front, cover and cylinder block with oil-resistant sealer. Position the gasket on the block and install the cylinder front cover (Fig. 19). Install the air conditioning drive belt idler pulley assembly, if so equipped. Torque the bolts to specifications.

23. Lubricate the damper end of the crankshaft with a white lead and oil mixture. Apply Lubriplate to the seal surfaces of the front oil seal and crankshaft damper. Install the crankshaft damper (Fig. 20). Install the accessory drive pulley if so equipped.

24. Apply a light film of engine oil on a new crankshaft rear oil seal and apply Lubriplate on the seal contact surface of the crankshaft. Install the seal (Fig. 37) flush to 0.005 inch below the face of the cylinder block.

25. Position the engine rear cover plate on the rear of the cylinder block and install the flywheel on the crankshaft. **Apply oil-resistant sealer to the threads of the flywheel attaching bolts.** Install the bolts and torque them to specifications.

26. Use a new gasket and install the inlet tube and screen on the oil pump. Prime the oil pump with engine oil. Position a new gasket on the oil pump body and install the oil pump and inlet tube assembly. Torque the attaching bolts to specifications.

27. Apply oil-resistant sealer in the cavities between the bearing cap and cylinder block (Fig. 41). Install a new oil pan rear seal in the rear main bearing cap, and apply a bead of oil-resistant sealer to the tapered ends of the seal.

28. Install new side gaskets on the oil pan with oil-resistant sealer (Fig. 40). Position a new cylinder front cover seal on the oil pan.

29. Coat both sides of a new water pump gasket with water-resistant sealer and position the gasket on the cylinder block. Coat the threads of the water pump bolts with water-resistant sealer. Install the water pump. Torque the bolts to specifications as outlined under Cylinder Head Installation.

30. Assemble the valves, springs, rocker arm, coolant outlet elbow, etc., following the procedures under Cylinder Head Assembly (Part 21-01, Section 2).

31. Place a new cylinder head gasket on the block. Carefully position the cylinder head carburetor, intake and exhaust manifold assembly on the block and install the bolts. Torque the bolts in sequence (Fig. 11) to specifications.

The cylinder head bolts are tightened in three progressive steps.

Torque the bolts to 50-55 ft-lbs, then to 60-65 ft-lbs. Finally, torque the bolts to specifications.

When cylinder head bolts have been tightened following this procedure, it is not necessary to retorque the bolts after extended operation. However, the bolts may be checked and retorqued, if desired.

32. Clean the exterior surface of the valve lifter with a clean, lintfree cloth and oil the surface with engine oil. Install the valve lifters (Fig. 27) in the same sequence that they were removed.

33. Apply Lubriplate to both ends of the push rods and to the push rod bores in the cylinder head. Install the push rods in the same sequence that they were removed. Be sure the push rods are properly seated in the valve lifters. Engage the rocker arms with the push rods and tighten the stud nuts sufficiently to hold the push rods in place.

34. Adjust the valve clearance.

35. Coat the gasket surface of the push rod cover with oil-resistant sealer and position a new gasket on the cover. Install the cover and gasket on the cylinder block. Torque the cover

bolts in sequence to specifications.

36. Install the carburetor with a new gasket.

37. Install a new gasket with oil-resistant sealer on the valve rocker arm cover. Install the cover on the cylinder head and torque the cover-screws in sequence to specifications. Then torque the bolts to specifications in the same sequence. Install the crankcase ventilation regulator valve in the rocker arm cover. Attach the vent hose to the intake manifold inlet tube.

38. Install the cylinder block drain plugs and oil pressure sending unit. Install the oil level dipstick tube and dipstick.

39. If equipped with air conditioning, install the compressor mounting bracket.

40. Install the alternator mounting bracket and adjusting arm bracket.

41. Install the water pump pulley, accessory drive pulley (if so equipped), spacer and cooling fan.

42. Install the oil filter mounting adapter. Coat the seal surface of a new oil filter with grease (or engine oil). Install the oil filter until the seal surface contacts the cylinder block; then tighten the filter an additional 1/2 turn.

43. Install the ignition coil and bracket assembly. Install the distributor vacuum advance control valve (deceleration valve).

44. Position No. 1 cylinder on TDC after the compression stroke. Set the distributor points to No. 1 cylinder firing position and install the distributor. With the distributor in points open position (No. 1 cyl.) install the hold down clamp and screw. Tighten the screw snug, but not tight.

45. Use a new gasket and install the fuel pump. Torque the bolts alternately and evenly to specifications. Install the carburetor fuel inlet line and distributor vacuum line.

46. Install the distributor cap and spark plug wires as an assembly. Connect the spark plug wires. Connect the distributor primary and high tension wires to the ignition coil.

47. Remove the engine from the work stand. Install the engine front support insulators on the engine.

## 5 SPECIFICATIONS

### GENERAL SPECIFICATIONS

Engine	Compression Ratio	Bore and Stroke	Taxable Horsepower	Brake Horsepower	Gross Torque Ft.-Lbs.
240	9.2:1	4.00 x 3.18	38.4	150 @ 4000	234 @ 2200
				155 @ 4200①	239 @ 2200①

①Police and Taxi

### GENERAL SPECIFICATIONS (Continued)

Engine	Compression Pressure PSI (Sea Level) @ Cranking Speed①	Engine Idle Manifold Vacuum①	Oil Pressure-Hot @ 2000 RPM	Firing Order	Belt Tension (Ft. Lbs.)②
240	When checking compression, take the highest compres- sion reading and compare it to the lowest reading. The lowest reading must be within 75% of the highest.	14	35-60	1-5-3- 6-2-4	New      Used 140    110

①See Compression Pressure Limit Chart in Part 21-01

②Minimum inches of Mercury @ specified engine RPM (seal level). This includes automatic transmission in neutral. Subtract 1 inch of Mercury for engines equipped with dual diaphragm distributors.

③All belts.

### ENGINE PERFORMANCE SPECIFICATIONS

Engine	Curb Idle RPM①	Fast Idle RPM②	Initial Ignition Timing③
240	Standard Transmission 800/500④ Automatic Transmission 500	Standard Transmission 0.029 Automatic Transmission 0.035	6°

①Headlamps on Hi Beam—Air Conditioning OFF

②Higher idle speed with solenoid energized and lower idle speed with solenoid de-energized.

③Throttle Plate Clearance—See Part 23-01

④Distributor vacuum line disconnected

### ENGINE PERFORMANCE SPECIFICATIONS (Continued)

Engine	Dwell Angle At Idle Speed	Distributor Point Gap	Spark Plug Gap	Spark Plug No.①
240	35-40	0.027	0.032-0.036	BF-42②

①Installation torque 15-20 Ft.-Lbs.

②Taxi and Police use BTF6

### ENGINE PERFORMANCE SPECIFICATIONS (Continued)

Engine	Anti-Stall Dashpot Clearance		Automatic Choke Setting		Idle Air-Fuel Ratio	
	Manual	Automatic	Manual	Automatic	Manual	Automatic
240-1V	Solenoid Equipped	7/64"	Index	1-Lean	14.45	14.70

### CYLINDER HEAD

Engine	Combustion Chamber Volume	Valve Guide Bore Diameter (Standard Intake and Exhaust)	Valve Seat Width		Valve Seat Angle	Valve Seat Runout (Maximum)	Valve Arrangement (Front to Rear)	Rocker Arm Stud Bore Dia. Std.	Gasket Surface Flatness ①
			Intake	Exhaust					
240	660/690	0.3433- 0.3443	0.060- 0.080	0.070- 0.090	Intake and Exhaust 45°	0.0015	E-I-E-I-E-I- E-I-E-I-E-I	0.3680- 0.3695	0.003 in any 6 inches 0.007 over- all

①Head Gasket Surface Finish R.M.S. ..... 90-150

## VALVE ROCKER ARMS, ROCKER ARM SHAFT, PUSHRODS AND TAPPETS

Engine	Rocker Arm Lift Ratio	Valve Push Rod (Maximum Runout)	VALVE TAPPET OR LIFTER		
			Standard Diameter	Clearance To Bore①	Hydraulic Lifter Leakdown Rate
240	1.61:1	0.025	0.8740- 0.8745	0.0007 0.0020	5-50 Seconds Maximum— Measured at 1/16 Inch plunger travel
① Wear Limit - 0.005					

## VALVE SPRINGS

Engine	Valve Spring Pressure Lbs @ Specified Length			Valve Spring Free Length Approximate	Valve Spring Assembled Height Pad to Retainer	Valve Spring Out-of-Square (Maximum)
	Pressure	Wear-Limit				
240	78-84 @ 1.700 187-207 @ 1.300	68 @ 1.700 166 @ 1.300		1.99	1 21/32-1 23/32	
240 Police and Taxi- Intake Exhaust	76-84 @ 1.700 187-207 @ 1.300	68 @ 1.700 166 @ 1.300		1.99	1 17/32 - 1 19/32	5/64 (.078)
	77-85 @ 1.580 182-202 @ 1.180	69 @ 1.580 164 @ 1.180		1.87		

## VALVES

Engine	Valve Stem To Valve Guide Clearance		Valve Stem To Rocker Arm Clearance		Valve Head Diameter		Valve Face Angle ④	Min. Allowable Valve Stem Tip Length
			Hydraulic Lifters					
	Intake	Exhaust	Allowable	Desired	Intake	Exhaust		
240	0.0010 0.0027	0.0010 0.0027 ①	0.082-0.152 ②	0.117	1.772-1.787	1.552-1.567	Intake and Exhaust 44°	7/32 (0.218)

① Wear Limit 0.0055  
 ② Valve face runout ..... Maximum 0.0020  
 ③ Hydraulic Valve Lifter Adjustment Turns down after contact ..... 1

## VALVES (Continued)

Engine	Valve Stem Diameter							
	Standard		0.003 Oversize		0.015 Oversize		0.030 Oversize	
	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust
240	0.3416- 0.3423	0.3416- 0.3423	0.3446- 0.3453	0.3446- 0.3453	0.3566- 0.3573	0.3566- 0.3573	0.3716- 0.3723	0.3716- 0.3723

## CAMSHAFT

Engine	Lobe Lift①		Theoretical Valve Lift		Camshaft		Camshaft Journal To Bearing Clearance	
	Intake	Exhaust	Intake	Exhaust	End Play	Wear Limit	Clearance	Wear Limit
240	0.2330	0.2490	0.3760	0.4000	0.003-0.007		0.001-0.003	0.006

① Maximum allowable lobe lift loss (All engines) ..... 0.005

**CAMSHAFT (Continued)**

Item	Bearing	240	Camshaft Valve Timing Events	
			Item	240
Camshaft Journal Diameter— Standard①	(No. 1)	2.0170-2.0180	Intake Valve Opens (BTDC)	0.003 @ 10°
	(No. 2)		Intake Valve Closes (ABDC)	0.004 @ 62°
	(No. 3)			
	(No. 4)			
	(No. 5)			
Camshaft Bearings Inside Diameter	(No. 1)	2.0190-2.0200	Exhaust Valve Opens (BBDC)	0.003 @ 49°
	(No. 2)			
	(No. 3)			
	(No. 4)			
	(No. 5)		Exhaust Valve Closes (ATDC)	0.004 @ 25°
Camshaft Bearing Location②	(No. 1)	0.200-0.0350		

① Camshaft journal maximum runout ..... 0.005  
   Camshaft journal maximum out-of-round ..... 0.0005  
 ② Distance in inches that the front edge of the bearing is installed towards the rear from the front face of the cylinder block.

CA1059-A

## PISTON

Engine	Diameter ①			Piston To Cylinder Bore Clearance	Piston Pin Bore Diameter	Ring Groove Width
	Coded Red	Coded Blue	0.003 Oversize			
240	3.9984- 3.9990	3.9996- 4.0002	4.0008- 4.0014	0.0014-0.0022	0.9123- 0.9126	Upper Compression Ring ..... 0.080-0.081 Lower Compression Ring ..... 0.080-0.081 Oil Ring ..... 0.1880-0.1890
Measured at the piston pin bore centerline at 90° to the pin bore.						

## PISTON PIN

Engine	Diameter				To Piston Clearance ②	To Connecting Rod Bushing Clearance
	Length	Standard	0.001 Oversize	0.002 Oversize		
240	3.156-3.170	0.9750-0.9753	0.9760-0.9763	0.9770-0.9773	0.0002-0.0004	Interference Fit
②Wear Limit	0.0008					

## PISTON RINGS

Engine	Ring Width		Side Clearance			Ring Gap Width		Oil Ring ④	
	Compression Ring		Compression Ring ③		Oil Ring	Compression Ring			
	Top	Bottom	Top	Bottom		Top	Bottom		
240	0.077-0.078	0.077-0.078	0.002-0.004	0.002-0.004	Snug	0.010-0.020	0.010-0.020	0.015-0.055	
③Wear Limit (All Engines) .....	0.006	④Steel Rail							

## OIL PUMP

Engine	Rotor Type Oil Pump Relief Valve Spring Tension Lbs @ Specified Length		Drive Shaft To Housing Bearing Clearance	Relief Valve Clearance	Rotor Assembly End Clearance	Outer Race To Housing (Radial Clearance)
	Top	Bottom				
240		20.6-22.6 @ 2.49	0.0015-0.0029	0.0015-0.0029	0.0011-0.0041	0.006-0.0013

## APPROXIMATE OIL PAN CAPACITIES⑤

Engine	U.S. Measure	Imperial Measure
240	4 1/2 Quarts	3 1/2 Quarts

⑤Includes one quart with filter replacement

## TORQUE LIMITS

Engine	Cylinder Head Bolts			Oil Pan To Cylinder Block	Manifolds To Cylinder Head		Water Outlet Housing	Distributor Vacuum Control Valve	Flywheel Crankshaft
	Step 1	Step 2	Step 3		Intake	Exhaust			
240	55	65	70-75	7-9	23-28	23-28	12-15	15-18	75-85

## TORQUE LIMITS (Continued)

Engine	Main Bearing Cap Bolts	Oil Pan Drain Plug	Oil Pump To Cylinder Block	Oil Pump Cover Plate	Oil Filter Adapter To Cylinder Block	Oil Filter To Adapter Or Cylinder Block	Cylinder Front Cover
240	60-70	15-20	12-15	6-9	32-42	With grease on the gasket surface, hand-tighten until gasket contacts adapter face, then tighten 1/2 turn more.	15-20

## TORQUE LIMITS (Continued)

Engine	Water Pump To Cylinder Block Or Front Cover	Camshaft Sprocket To Camshaft	Camshaft Thrust Plate In Block	Damper Or Pulley To Crankshaft	Connecting Rod Nuts	Valve Rocker Arm Cover
240	15-20	35-45	19-21	130-150	40-45	7-9

## TORQUE LIMITS (Continued)

Engine	Oil Inlet Tube To Oil Pump	Fuel Pump To Cylinder Block Or Cylinder Front Cover	Pulley To Damper
240	12-15	12-15	UBS Bolts 25-35 Place Bolts 35-45

## TORQUE LIMITS (Continued)

Engine	Valve Rocker Arm Stud To Cylinder Head	Valve Push Rod Chamber Cover	Valve Rocker Arm Adjusting Nut
240		1.0-1.5	Removal Torque (Break-A-Way) Counterclockwise ..... 4.5-15 ft. lbs.

## ENGINE SUPPORT TORQUE LIMITS-FT LBS

Front Supports	240
Insulator to Engine	35-40
Insulator Bracket to Engine	35-40
Insulator to Support Bracket	45-60
Support Bracket to Frame	20-30
Rear Supports	
Support to Transmission	40-50
Support to Crossmember	20-30
Crossmember to Frame	30-50

## TORQUE LIMITS FOR VARIOUS SIZE BOLTS-FT LBS

Caution: If any of the torque limits listed in this table disagree with any of those listed in the preceding tables, the limits listed in the preceding tables prevail.						
Size (Inches)	1/4-20	1/4-28	5/16-18	5/16-24	3/8-16	3/8-24
Torque (Ft-lbs)	6-9	6-9	12-15	15-18	23-28	30-35
Size (Inches)	7/16-14	7/16-20	1/2-13	1/2-20	9/16-18	5/8-18
Torque (Ft-lbs)	45-50	50-60	60-70	70-80	85-95	130-145

## PART 21-04 302 and 351W Engines

MODEL APPLICATION	302-2V—Ford, Meteor, Fairlane, Falcon, Montego, Mustang and Cougar	302 BOSS—Mustang and Cougar 351-W—Ford, Meteor, Mustang and Cougar
<b>COMPONENT INDEX</b>		<b>Page</b>
<b>CAMSHAFT</b>	Bearing Removal and Installation ..... Bearing Bore Plug Removal and Installation ..... Camshaft Installation ..... Camshaft Removal .....	04-30 04-18 04-18 04-17
<b>CLUTCH PILOT BUSHING</b>	Installation ..... Removal .....	04-24 04-23
<b>CONNECTING ROD BEARING</b>	Installation ..... Removal .....	04-21 04-21
<b>CRANKCASE VENTILATION SYSTEM</b>	Description ..... Installation ..... Removal .....	04-02 04-12 04-12
<b>CRANKSHAFT</b>	Front Seal Removal and Installation ..... Installation ..... Rear Seal Removal and Installation ..... Removal .....	04-17 04-29 04-20 04-28
<b>CYLINDER ASSEMBLY (SHORT BLOCK)</b>	Assembly ..... Disassembly .....	04-30 04-30
<b>CYLINDER BLOCK</b>	Assembly ..... Disassembly .....	04-30 04-30
<b>CYLINDER FRONT COVER AND TIMING CHAIN</b>	Installation ..... Removal .....	04-16 04-15
<b>CYLINDER HEAD</b>	Assembly ..... Disassembly .....	04-14 04-14
<b>ENGINE</b>	Assembly ..... Description ..... Disassembly ..... Installation ..... Removal .....	04-31 04-02 04-30 04-27 04-27
<b>ENGINE FRONT SUPPORTS</b>	Installation ..... Removal .....	04-05 04-04
<b>ENGINE REAR SUPPORTS</b>	Installation ..... Removal .....	04-05 04-05
<b>COMPONENT INDEX</b>		<b>Page</b>
<b>EXHAUST EMISSION CONTROL SYSTEM</b>	Description .....	04-02
<b>EXHAUST MANIFOLD</b>	Installation ..... Removal .....	04-12 04-11
<b>FLYWHEEL</b>	Installation ..... Removal .....	04-23 04-23
<b>INTAKE MANIFOLD</b>	Installation ..... Removal .....	04-10 04-10
<b>MAIN BEARING</b>	Installation ..... Removal .....	04-20 04-20
<b>OIL COOLER—302 BOSS</b>	Installation ..... Removal .....	04-12 04-12
<b>OIL FILTER</b>	Cartridge Type Removal and Installation ..... Element Type Removal and Installation .....	04-24 04-24
<b>OIL PAN</b>	Installation ..... Removal .....	04-25 04-24
<b>OIL PUMP</b>	Assembly ..... Disassembly ..... Installation ..... Removal .....	04-26 04-26 04-26 04-26
<b>PISTON AND CONNECTING ROD</b>	Assembly ..... Disassembly .....	04-22 04-22
<b>ROCKER ARM AND ROCKER ARM COVER</b>	Installation ..... Removal .....	04-09 04-09
<b>SPECIFICATIONS</b>	.....	04-34
<b>THERMACTOR AIR BY-PASS VALVE</b>	Installation ..... Removal .....	04-06 04-06
<b>THERMACTOR AIR FILTER FAN</b>	Installation ..... Removal .....	04-06 04-06
<b>THERMACTOR AIR PUMP</b>	Installation ..... Removal .....	04-07 04-07

COMPONENT INDEX	Page	COMPONENT INDEX	Page
<b>THERMACTOR AIR PUMP PULLEY</b>		Valve Clearance Adjustment—Mechanical	04-08
Installation .....	04-06	Tappet .....	04-08
Removal .....	04-06	Valve Clearance Check—Hydraulic Valve	04-07
Lifter .....		Lifter .....	04-07
<b>THERMACTOR CHECK VALVE</b>		<b>VALVE LIFTER</b>	
Installation .....	04-06	Assembly .....	04-19
Removal .....	04-06	Disassembly .....	04-19
<b>THERMACTOR DRIVE BELT</b>		Installation .....	04-19
Adjustment .....	04-05	Removal .....	04-19
Installation .....	04-06	<b>VALVE SPRING</b>	
Removal .....	04-05	Installation .....	04-15
<b>THERMACTOR RELIEF VALVE</b>		Removal .....	04-14
Installation .....	04-07	<b>VALVE SPRING RETAINER</b>	
Removal .....	04-07	Installation .....	04-15
<b>THERMACTOR RELIEF VALVE PRESSURE SETTING PLUG</b>		Removal .....	04-14
Installation .....	04-07	<b>VALVE STEM SEAL</b>	
Removal .....	04-07	Installation .....	04-15
<b>VALVE</b>		Removal .....	04-14
Valve Clearance Adjustment—Hydraulic Valve		<b>WATER PUMP</b>	
Lifter .....	04-08	Installation .....	04-15
		Removal .....	04-15

## 1 DESCRIPTION

### ENGINE

The 302-2V, 302 BOSS and 351-W V-8 engines (Figs. 1, 2 and 3) have a piston displacement of 302 and 351 cubic inches respectively.

An engine identification tag is located on the alternator adapter on 302 CID engines and on the ignition coil bracket on 351-W engines. Refer to Part 21-01, Section 1 for engine

tag code.

Thermactor exhaust emission control system.

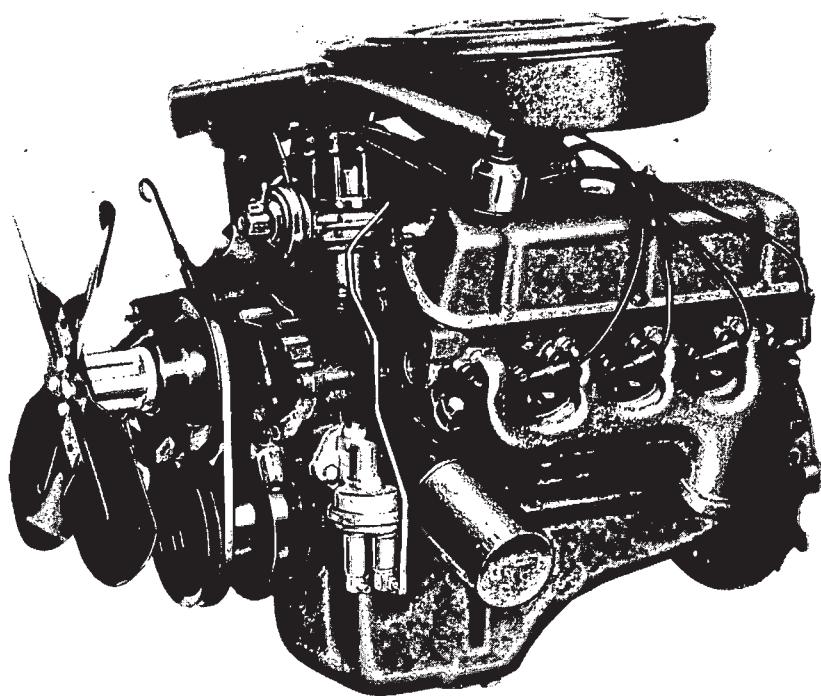
### EXHAUST EMISSION CONTROL SYSTEM

The 302-2V and 351-W engines use the Imco exhaust emission control system to keep exhaust gas contaminants at an acceptable level.

The 302 BOSS engine uses the

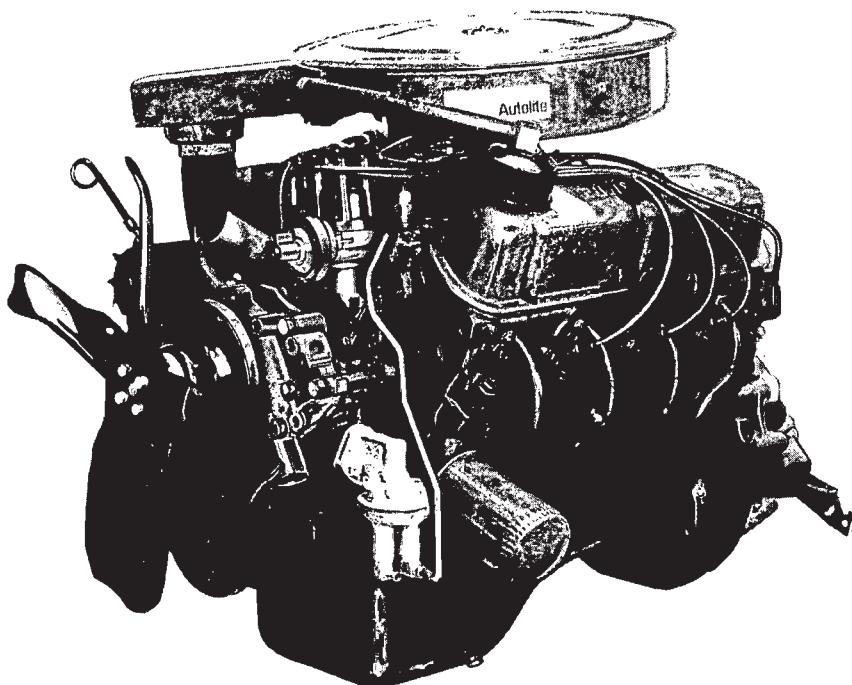
### CRANKCASE VENTILATION SYSTEM

The engine is equipped with a positive closed-type crankcase ventilation system directing the crankcase vapors to the intake manifold.



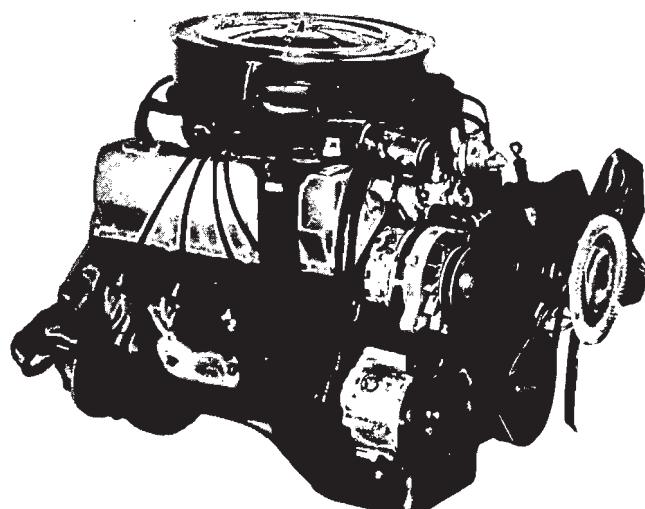
A2715-B

FIG. 1—3/4 Left Front View—302-2V V-8



A3140-B

FIG. 2—3/4 Left Front View—351-W V-8



A3287-A

**FIG. 3—3/4 Right Front View—302 BOSS Engine**

## 2 IN-VEHICLE ADJUSTMENTS AND REPAIRS

When installing nuts or bolts that must be torqued (refer to Section 5 for torque specifications), oil the threads with light weight engine oil. **Do not oil threads that require oil-resistant or water-resistant sealer.**

Refer to Part 21-01, Section 3 for cleaning and inspection procedures.

Refer to Part 21-01, Section 1 for test procedures.

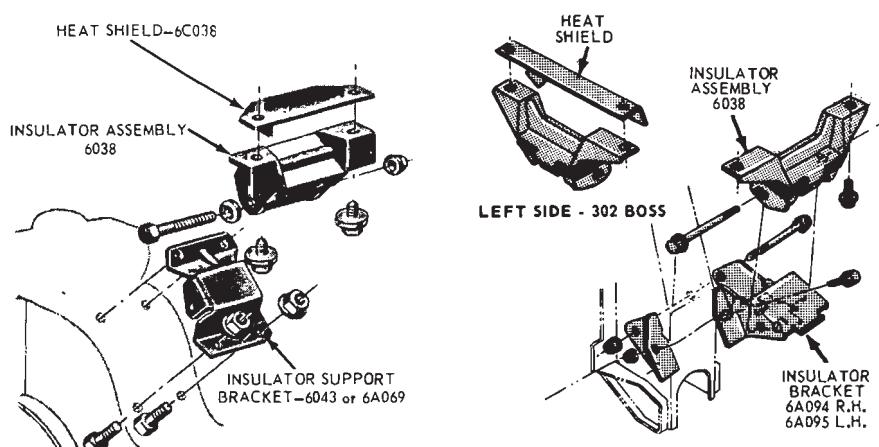
If the engine identification tag is removed while servicing the engine, be sure to reinstall it in its original location.

### ENGINE FRONT SUPPORTS

The front supports are located on each side of the cylinder block (Figs. 4, 5 and 6). The procedures given apply to either a right or left installation.

#### REMOVAL

1. Remove the nut and through



**FIG. 4—Engine Front Supports—Ford and Meteor**

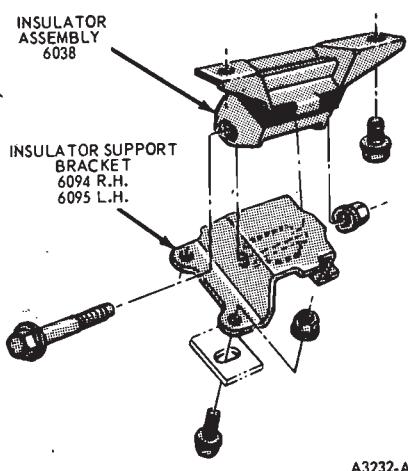
bolt attaching the insulator to the insulator support bracket (Figs. 4, 5 and 6).

2. Raise the engine slightly with a

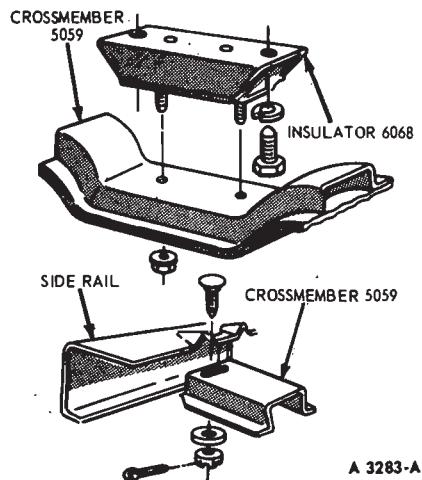
**FIG. 5—Engine Front Supports—Mustang and Cougar**

jack and a wood block placed under the oil pan.

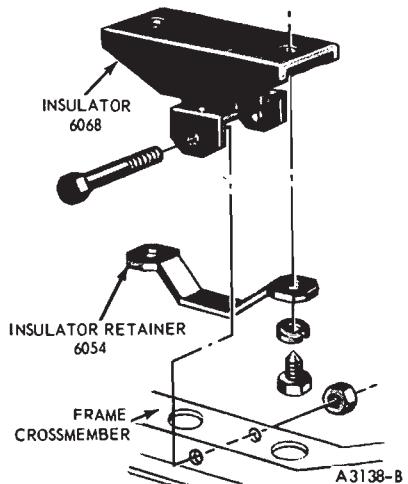
3. Remove the engine insulator attaching



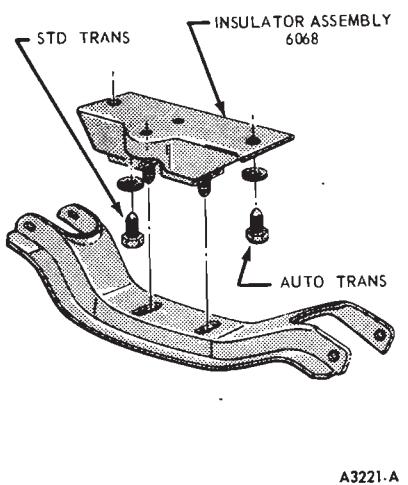
**FIG. 6—Engine Front Supports—Fairlane, Falcon and Montego**



**FIG. 9—Engine Rear Supports—Fairlane, Falcon and Montego**



**FIG. 7—Engine Rear Supports—Ford and Meteor**



**FIG. 8—Engine Rear Supports—Mustang and Cougar**

## INSTALLATION

1. Position the support insulator and retainer on the transmission extension housing.

2. Install the support insulator to transmission extension housing bolts and lock washers. Torque the bolts to specifications. Lower the transmission.

3. On Ford and Meteor models, install the support insulator to crossmember through bolt and lock nut. Torque the nut to specifications.

On Fairlane, Falcon, Montego, Mustang and Cougar models, install the support insulator to crossmember attaching nuts. Tighten the nuts to specifications.

## THERMATOR AIR PUMP DRIVE BELT

### ADJUSTMENT

The air supply pump drive belt should be properly adjusted at all times. A loose drive belt causes improper air pump operation. A belt that is too tight places a severe strain on the air pump bearings.

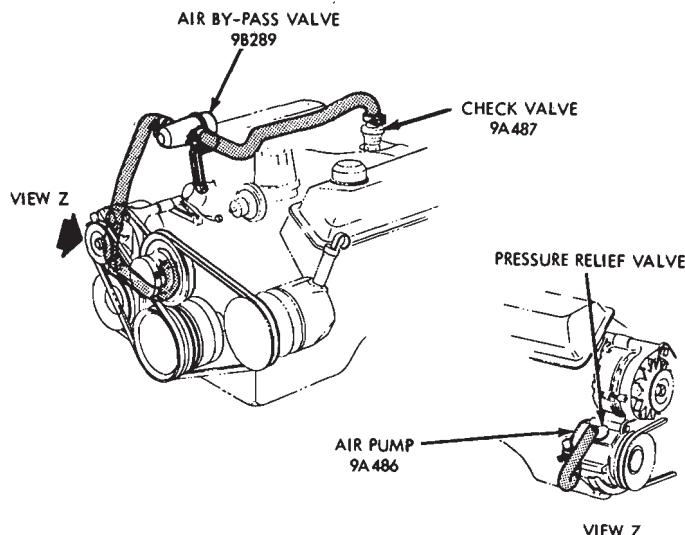
Properly tensioned drive belts minimize noise and also prolong service life of the belt. A belt tension gauge should be used to adjust and check the belt tension. Any belt that has operated for a minimum of 10 minutes is considered a used belt, and, when adjusted, it must be adjusted to the tension shown in the specifications for used belts.

1. Install the belt tension tool (T63L-8620-A) on the drive belt and check the tension following the instructions of the tool manufacturer. Compare the belt tension to the specified belt tension and adjust as necessary.

2. If adjustment is necessary, loosen the air pump mounting and adjusting arm bolts (Fig. 10). Move the air pump toward or away from the engine until the correct tension is obtained. Use a suitable bar and pry against the pump rear cover to hold belt tension while tightening the mounting bolts. Do not pry against the pump housing. Remove the gauge. Tighten the air pump adjusting arm and mounting bolts. Install the tension gauge and check the belt tension.

### REMOVAL

1. Loosen the alternator adjustment arm bolt and remove the alternator drive belt.



ANY MODIFICATION OF THE THERMACTOR EXHAUST EMISSION SYSTEM, PRIOR TO THE FIRST SALE AND REGISTRATION OF THE VEHICLE, IS SUBJECT TO THE PENALTIES OF FEDERAL (U.S.A.) LAW AND TO THE PENALTIES UNDER THE LAWS OF SOME STATES THEREAFTER.

A3228-A

FIG. 10—Thermactor System Installation

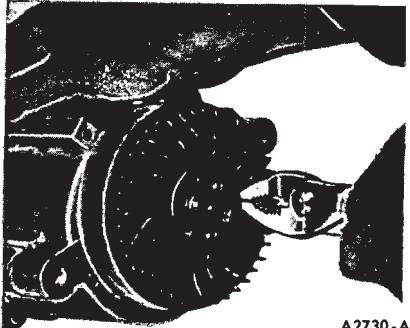


FIG. 11—Removing Thermactor Air Pump Centrifugal Filter Fan

2. If equipped with power steering, loosen the adjusting arm and remove the power steering pump drive belt.

3. Loosen the air supply pump adjusting arm bolt (Fig. 10). Loosen the air supply pump to mounting bracket bolt, and push the air pump towards the cylinder block. Remove the drive belt.

#### INSTALLATION

1. Install a new drive belt. With a suitable bar, pry against the rear cover of the air pump to obtain the specified belt tension (refer to Section 5), and tighten the adjusting arm bolt. Do not pry against the pump housing.

Always use a belt tension gauge (Tool T63L-8620-A) to check belt tension.

2. Tighten the air supply pump to mounting bracket bolt.
3. Install the power steering pump drive belt if so equipped.
4. Install the alternator drive belt.
5. Adjust the drive belts to specifications.

#### THERMACTOR AIR BY-PASS VALVE

##### REMOVAL

Disconnect the air and vacuum hoses at the air bypass valve body (Fig. 10).

##### INSTALLATION

1. Position the air bypass valve properly, and connect the air and vacuum hoses. Position the output air hose clamp over the air bypass valve bracket.
2. Tighten the air hose clamps.

#### THERMACTOR CHECK VALVE

##### REMOVAL

Disconnect the air supply hose at the valve. Use a 1-1/4 inch crowfoot

wrench to unscrew the check valve assembly (the valve has a standard, pipe thread).

#### INSTALLATION

Clean the threads on the intake manifold adapter with a wire brush. Install the check valve and torque it to specifications. Connect the air supply hose.

#### THERMACTOR AIR PUMP DRIVE PULLEY

##### REMOVAL

1. Loosen the air supply pump adjusting arm and mounting bolts to relieve the belt tension.
2. Remove the drive pulley attaching bolts and pull the drive pulley off the air pump shaft.

##### INSTALLATION

1. Position the drive pulley on the air supply pump shaft, and install the attaching bolts. Torque the bolts to specifications.

2. Position the drive belt and adjust the belt tension to specifications. Tighten the adjusting arm and mounting bolts.

#### THERMACTOR AIR PUMP CENTRIFUGAL FILTER FAN

##### REMOVAL

1. Loosen the air supply pump adjusting arm bolt and mounting bracket bolt to relieve drive belt tension.

2. Remove the drive pulley attaching bolts and pull the drive pulley off the air pump shaft.

3. Pry the outer disc loose and then pull off the centrifugal filter fan as shown in Fig. 11. Care should be taken to prevent fragments from entering the air intake hole if the fan breaks when removing. Do not attempt to remove the metal drive hub.

##### INSTALLATION

1. Install the new filter fan by drawing it into position, using the pulley and bolts as an installer. Draw the fan evenly by alternately tightening the bolts, making certain that the outer edge of the fan slips into the housing.

A slight amount of interference with the housing bore is normal, and some initial noise during run-in may be expected.

2. Position the drive belt and adjust the belt tension to specification. Tighten the adjusting arm and mounting bolts.

#### THERMACTOR AIR SUPPLY PUMP

##### REMOVAL

1. Disconnect the air outlet hose at the air pump.

2. Loosen the adjusting arm to air pump and air pump to mounting bracket bolts to relieve the drive belt tension.

3. Disengage the drive belt. Remove the mounting bolt and air pump.

##### INSTALLATION

1. Position the air pump on the

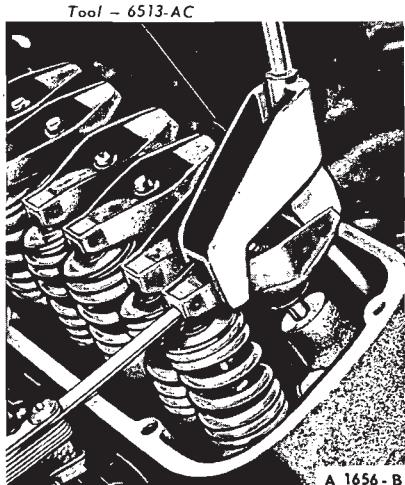


FIG. 12—Checking Valve Clearance—Hydraulic Valve Lifters

mounting bracket and install the mounting bolt.

2. Place the drive belt in the pulleys and attach the adjusting arm to the air pump. Adjust the drive belt tension to specifications and tighten the adjusting arm and mounting bolts.

3. Connect the air outlet hose to the air pump.

#### THERMACTOR AIR PUMP RELIEF VALVE

**Do not disassemble the air pump to replace the relief valve, but remove it from the engine.**

##### REMOVAL

Position Tool T66L-9A486-D on the air pump and remove the relief valve with the aid of a slide hammer (T59L-100-B).

##### INSTALLATION

Position the relief valve on the pump housing and hold Tool T66L-9A486-B on the relief valve. Use a hammer to tap the tool lightly until the relief valve is seated.

#### THERMACTOR RELIEF VALVE PRESSURE-SETTING PLUG

##### REMOVAL

Compress the three locking tabs inward (together) and remove the plastic pressure-setting plug.

##### INSTALLATION

1. Before installing the new plug, be sure that the plug is the correct

one. The correct plug for this engine should be color-coded blue.

2. Insert the plug in the relief valve hole, and push the plug in until it snaps into place.

#### VALVES

##### VALVE CLEARANCE CHECK—HYDRAULIC VALVE LIFTERS

The valve arrangement on the left bank is E-I-E-I-E-I-E-I and on the right bank is I-E-I-E-I-E-I-E.

A 0.060-inch shorter push rod or a 0.060-inch longer push rod are available for service to provide a means of compensating for dimensional changes in the valve mechanism. Refer to the Master Parts List for the pertinent color code.

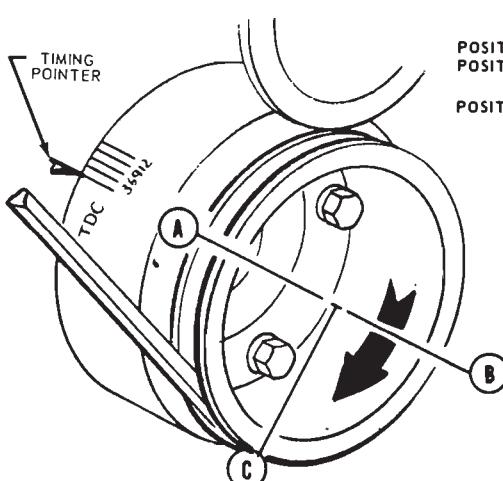
Valve stem to valve rocker arm clearance should be within specifications with the hydraulic lifter completely collapsed. Repeated valve reconditioning operations (valve and/or valve seat refacing) will decrease the clearance to the point that if not compensated for, the hydraulic valve lifter will cease to function and the valve will be held open.

To determine whether a shorter or a longer push rod is necessary, make the following check:

1. Disconnect the brown lead (I terminal) and the red and blue lead (S terminal) at the starter relay. Install an auxiliary starter switch between the battery and S terminals of the Starter relay. Crank the engine with the ignitions switch OFF until the No. 1 piston is on TDC after the compression stroke.

2. With the crankshaft in the

With No. 1 at TDC at end of compression stroke make a chalk mark or paint B and C approximately 90 degrees apart.



**POSITION A** — No. 1 at end of compression stroke.  
**POSITION B** — Rotate the crankshaft 180 degrees (one half revolution) clockwise from POSITION A.  
**POSITION C** — Rotate the crankshaft 270 degrees (three quarter revolution) clockwise from POSITION B.

A3234-A

FIG. 13—Position of Crankshaft for Checking and Adjusting Valve Clearance

positions designated in Steps 3, 4 and 5 position the hydraulic lifter compressor tool on the rocker arm. Slowly apply pressure to bleed down the hydraulic lifter until the plunger is completely bottomed (Fig. 12). Hold the lifter in this position and check the available clearance between the rocker arm and the valve stem tip with a feeler gauge. The feeler gauge width must not exceed 3/8-inch.

If the clearance is less than specifications, install an undersize push rod. If the clearance is greater than specifications, install an oversize push rod.

3. With the No. 1 piston on TDC at the end of the compression stroke, POSITION A in Fig. 13, check the following valves:

#### 302 Engines

No. 1 Intake	No. 1 Exhaust
No. 7 Intake	No. 5 Exhaust
No. 8 Intake	No. 4 Exhaust

#### 351-W Engines

No. 1 Intake	No. 1 Exhaust
No. 4 Intake	No. 3 Exhaust
No. 8 Intake	No. 7 Exhaust

4. Rotate the crankshaft to POSITION B in Fig. 13 and check the following valves:

#### 302 Engines

No. 5 Intake	No. 2 Exhaust
No. 4 Intake	No. 6 Exhaust

#### 351-W Engines

No. 3 Intake	No. 2 Exhaust
No. 7 Intake	No. 6 Exhaust

5. Rotate the crankshaft to POSITION C in Fig. 13 and check the following valves:

#### 302 Engines

No. 2 Intake	No. 7 Exhaust
No. 3 Intake	No. 3 Exhaust
No. 6 Intake	No. 8 Exhaust

#### 351-W Engines

No. 2 Intake	No. 4 Exhaust
No. 5 Intake	No. 5 Exhaust
No. 6 Intake	No. 8 Exhaust

#### VALVE CLEARANCE ADJUSTMENT—HYDRAULIC VALVE LIFTERS

The positive stop rocker arm stud eliminates the necessity of adjusting

the valve clearance. However, to obtain the specified valve lash, it is important that all valve components be in a serviceable condition and installed and torqued properly.

1. With the crankshaft in the positions designated in steps 2, 3 and 4 remove the stud nut and inspect it for conditions shown in Fig. 17.

Install the stud nuts on the stud and turn the nut clockwise until it contacts the stop. Torque the stud nut to specifications.

2. With the No. 1 piston on TDC at the end of the compression stroke, POSITION A in Fig. 13, inspect the stud nut and install the stud nut on the following valves:

#### 302 Engines

No. 1 Intake	No. 1 Exhaust
No. 7 Intake	No. 5 Exhaust
No. 8 Intake	No. 4 Exhaust

#### 351-W Engines

No. 1 Intake	No. 1 Exhaust
No. 4 Intake	No. 3 Exhaust
No. 8 Intake	No. 7 Exhaust

3. Rotate the crankshaft to POSITION B in Fig. 13. Inspect and install the stud nut on the following valves:

#### 302 Engines

No. 5 Intake	No. 2 Exhaust
No. 4 Intake	No. 6 Exhaust

#### 351-W Engines

No. 3 Intake	No. 2 Exhaust
No. 7 Intake	No. 6 Exhaust

4. Rotate the crankshaft to POSITION C in Fig. 13. Inspect and install the stud nut on the following valves:

#### 302 Engines

No. 2 Intake	No. 7 Exhaust
No. 3 Intake	No. 3 Exhaust
No. 6 Intake	No. 8 Exhaust

#### 351-W Engines

No. 2 Intake	No. 4 Exhaust
No. 5 Intake	No. 5 Exhaust
No. 6 Intake	No. 8 Exhaust

#### VALVE CLEARANCE

#### ADJUSTMENT—MECHANICAL TAPPET

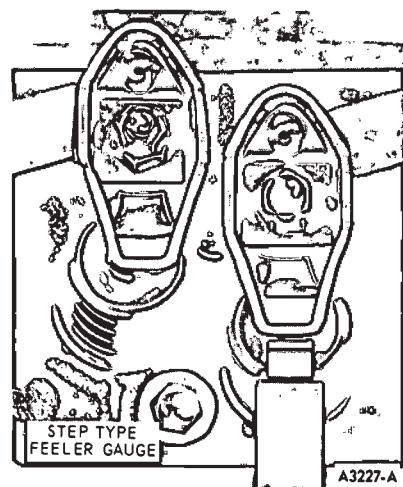


FIG. 14—Valve Lash Adjustment—Mechanical Tappet

#### Preliminary (Cold) Adjustment

If some component of the valve train has been replaced; i.e., rocker arm, push rod, camshaft, etc., it will be necessary to make a preliminary (cold) valve lash adjustment before starting the engine. If the valve lash adjustment is made for an engine tune-up, follow the final (hot) adjustment procedure.

The cylinders are numbered from front to rear—right bank, 1-2-3-4; left bank, 5-6-7-8.

The valves are arranged from front to rear, on the left bank, E-I-E-I-E-I-E-I, and on the right bank, I-E-I-E-I-E-I-E.

1. Disconnect the brown lead (I terminal) and the red and blue lead (S terminal) at the starter relay. Install an auxiliary starter switch between the battery and S terminals of the starter relay. Crank the engine with the ignition switch OFF.

2. With the crankshaft in the positions given in steps 3, 4 and 5, loosen the lock nut and set the valve lash (Fig. 14) to specifications with a step-type feeler gauge (go and no go). After adjusting each valve, torque the lock nut to specifications.

3. Rotate the crankshaft until No. 1 piston is on TDC at the end of the compression stroke POSITION A in Fig. 13. Adjust the following valves:

No. 1 Intake    No. 1 Exhaust  
No. 7 Intake    No. 5 Exhaust  
No. 8 Intake    No. 4 Exhaust

4. Rotate the crankshaft to POSITION B in Fig. 13. Adjust the following valves:

No. 5 Intake    No. 2 Exhaust  
No. 4 Intake    No. 6 Exhaust

5. Rotate the crankshaft to POSITION C in Fig. 13. Adjust the following valves:

- No. 2 Intake No. 7 Exhaust
- No. 3 Intake No. 3 Exhaust
- No. 6 Intake No. 8 Exhaust

#### Final (Hot) Adjustment

It is very important that the valve lash be held to the correct specifications because:

If the lash is set too close, the valve will open too early and close too late, resulting in rough engine idle. Burning and warping of the valves will occur also because the valves cannot make firm contact with the seats long enough to cool properly. If the lash is excessive, it will cause the valve to open too late and close too early causing valve bounce. In addition, damage to the camshaft lobe is likely because the tappet foot will not follow the pattern of the camshaft lobe causing a shock contact between these two parts.

1. Be sure the engine is at normal operating temperature before attempting to set the valve lash.

2. With the engine idling, set the valve lash (Fig. 14) using a step-type feeler gauge only (go and no go). The final (hot) intake and exhaust valve lash settings are listed in the Specifications (Section 5).

3. After adjusting each valve, torque the lock nut to specifications and recheck the valve lash.

#### VALVE ROCKER ARM COVER AND ROCKER ARM

The valve rocker arm assembly sequence is shown in Figs. 15 and 16.

#### REMOVAL

1. To remove a valve rocker arm from the right cylinder head, disconnect the automatic choke heat chamber air inlet hose from the inlet tube near the right valve rocker arm cover, if so equipped.

Remove the air cleaner and intake duct assembly.

Remove the automatic choke heat tube, if so equipped. Remove the crankcase ventilation regulator valve from the valve rocker arm cover.

2. Disconnect the spark plug wires from the spark plugs by grasping, twisting and pulling the molded cap only. Remove the wires from the bracket-on the valve rocker arm cover(s) and position the wires out of the way.

3. On a left side rocker arm cover, remove the wire harness from the retaining clips. Remove the valve rocker arm cover attaching bolts and remove the cover(s).

4. Remove the valve rocker arm stud nut (and lock nut on 302 BOSS engines), fulcrum seat and rocker arm.

If removal of the rocker arm stud is necessary, refer to the procedure under Cylinder Head Repairs in Part 21-01, Section 2.

#### INSTALLATION

All rocker arms and fulcrum seats are to be lubricated with heavy engine oil MS before installation.

1. Apply Lubriplate, or equivalent, to the top of the valve stem and fulcrum seats.

2. On 302-2V and 351-W engines, inspect the stud nut for damage as shown in Fig. 17. The chamfer on the nut should not be over  $1/16$ -inch wide. A nut with a chamfer larger than  $1/16$ -inch can cause the valves to be held open.

3. On 302-2V and 351-W engines, install the rocker arm, fulcrum seat and stud nut. Adjust the valve clearance following the procedure under Valve Clearance Adjustment—Hydraulic Valve Lifters.

On 302 BOSS engines, install the valve rocker arm, fulcrum seat, stud nut and lock nut. Adjust the valve lash following the procedures under Valve Clearance Adjustment—Mechanical Tappet.

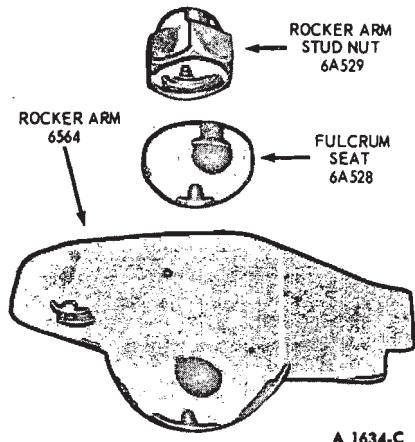
4. Clean the valve rocker arm cover(s) and the cylinder head gasket surface(s). Apply oil-resistant sealer to one side of new cover gasket(s). Lay the cemented side of the gasket(s) in place in the cover(s).

5. Position the cover(s) on the cylinder head(s). Make sure the gasket seats evenly all around the head. Install the bolts and wire loom clips on left hand cover. The cover is tightened in two steps. Torque the bolts to specifications. Two minutes later, torque the bolts to the same specifications.

If the right cover was removed, install the crankcase ventilation regulator valve. On 302-2V and 351-W engines, install the automatic choke heat tube and connect the automatic choke heat chamber air inlet hose at the air cleaner.

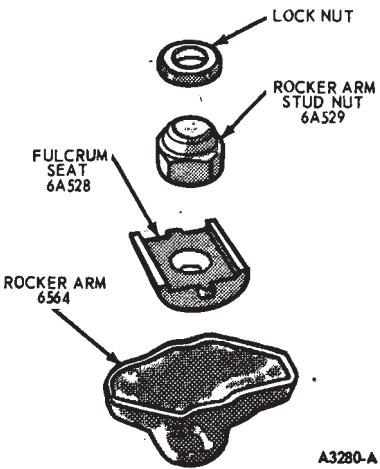
Install the air cleaner and intake duct assembly.

6. Install the spark plug wires in the bracket on the valve rocker arm



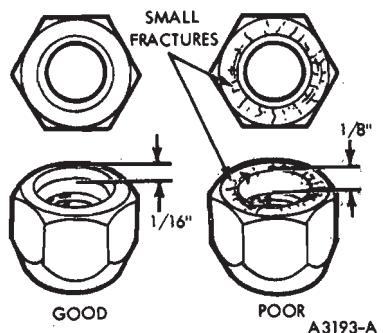
A 1634-C

**FIG. 15—Valve Rocker Arm—302-2V and 351-W Engines**



A3280-A

**FIG. 16—Valve Rocker Arm—302 BOSS Engines**



A3193-A

**FIG. 17—Inspection of Rocker Arm Stud Nut—302 and 351-W Engines**

cover(s). Connect the spark plug wires.

7. On a 302 BOSS engine, operate the engine until it reaches normal op-

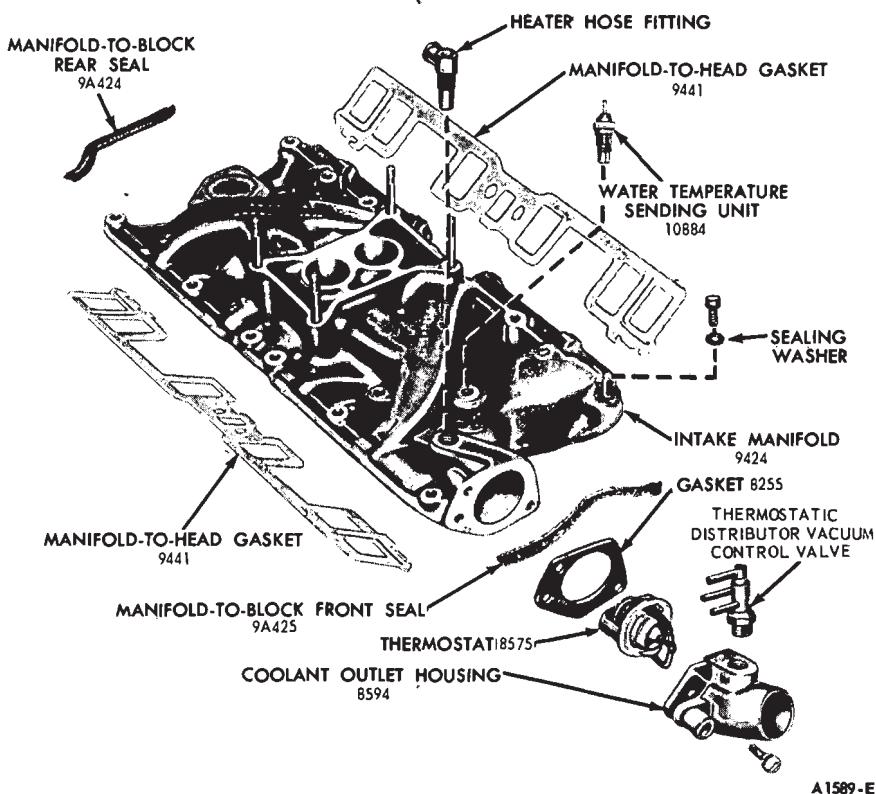


FIG. 18—Typical Intake Manifold Assembly

erating temperature. Remove the rocker arm cover(s) and perform a final valve adjustment following procedures under Valve Clearance Adjustment—Mechanical Tappet.

### INTAKE MANIFOLD

The intake manifold assembly is shown in Fig. 18.

### REMOVAL

1. Drain the cooling system. On 302-V and 351-W engines, disconnect the automatic choke heat chamber air inlet hose at the inlet tube near the right valve rocker arm cover. Remove the air cleaner and intake duct assembly.

On 302 BOSS engines, disconnect the Thermactor air hose from the check valve at the rear of the intake manifold and loosen the hose clamp at the hose bracket. Remove the air hose and Thermactor air by-pass valve from the bracket and position out of the way.

2. Disconnect the accelerator rod or cable from the carburetor and/or manifold brackets. Remove the accelerator retracting spring.

On 302 BOSS engines, disconnect the choke cable from the carburetor.

Disconnect automatic transmission and power brake booster vacuum lines, if so equipped, at the intake manifold.

3. Disconnect the high tension lead and wires from the coil.

4. Disconnect the spark plug wires from the spark plugs by grasping, twisting and pulling the moulded cap only. Remove the wires from the harness brackets on the valve rocker arm covers. Remove the distributor cap and spark plug wire assembly.

5. Remove the carburetor fuel inlet line and the automatic choke heat tube, if so equipped.

6. Disconnect the distributor vacuum hoses from the distributor. Remove the distributor hold down bolt and remove the distributor.

7. Disconnect the radiator upper hose from the coolant outlet housing, and the water temperature sending unit wire at the sending unit. Remove the heater hose from the automatic choke housing and disconnect the hose from the intake manifold.

8. Loosen the clamp on the water pump bypass hose at the coolant outlet housing and slide the hose off the outlet housing.

9. Disconnect the crankcase vent hose at the valve rocker arm cover.

10. If the vehicle is equipped with

an air conditioner, remove the compressor to intake manifold brackets.

11. Remove the intake manifold and carburetor as an assembly. It may be necessary to pry the intake manifold away from the cylinder head(s). Use caution to avoid possible damage to the gasket sealing surfaces. Remove the intake manifold gaskets and seals. Discard the intake manifold attaching bolt sealing washers.

12. If the manifold assembly is to be disassembled, identify all vacuum hoses before disconnecting them. Remove the coolant outlet housing, gasket and thermostat. Remove the ignition coil, temperature sending unit, carburetor, spacer, gaskets and Thermactor check valve, if so equipped.

### INSTALLATION

1. If the intake manifold assembly was disassembled, install the temperature sending unit (threads coated with electrical conductive sealer), ignition coil (and identification tag on 351-W engines), carburetor, spacer, gaskets and Thermactor check valve, if so equipped. Position the thermostat in the coolant outlet housing. Coat the thermostat gasket with water-resistant sealer and position it on the coolant outlet housing. Install the coolant outlet housing. Connect all vacuum hoses following the schematic shown in Part 22-01.

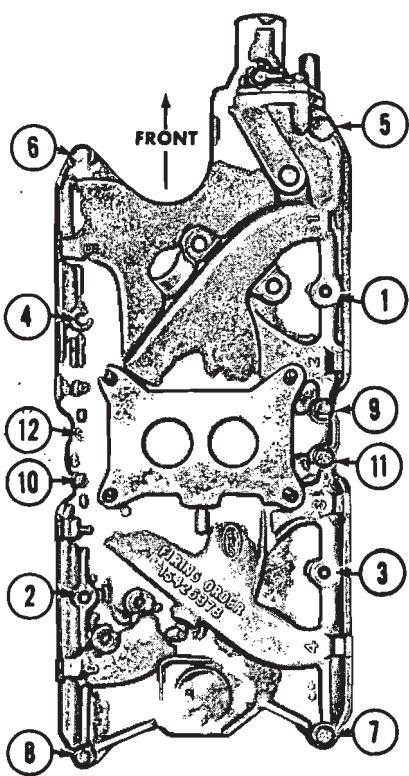
2. Clean the mating surfaces of the intake manifold, cylinder heads and cylinder block. Use a suitable solvent to remove all traces of oil. Coat the cylinder block seal surfaces with contact adhesive.

3. Position new seals on the cylinder block and new gaskets on the cylinder heads with the gaskets interlocked with the seal tabs. Be sure the holes in the gaskets are aligned with the holes in the cylinder heads.

Apply non-hardening sealer at the four junction points of the seals and gaskets.

4. Carefully lower the intake manifold into position on the cylinder block and cylinder heads. After the intake manifold is in place, run a finger around the seal area to make sure the seals are in place. If the seals are not in place, remove the intake manifold and position the seals.

5. Be sure the holes in the manifold gaskets and manifold are in alignment. Install the intake manifold attaching bolts and nuts. Torque the intake manifold bolts in sequence to 20-22 ft-lbs. (Figs. 19, 20 and 21).



**FIG. 19—Intake Manifold Torque Sequence—302-2V CID**

Repeat the torque sequence to specifications.

After completing the remaining assembly steps, operate the engine until it reaches normal operating temperature, then retorque the manifold bolts in sequence to specifications.

6. Install the water pump bypass hose on the coolant outlet housing. Slide the clamp into position and tighten the clamp.

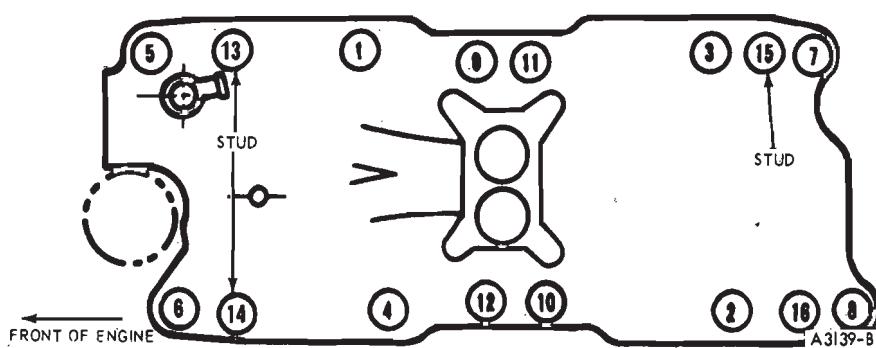
7. Connect the radiator upper hose. Install the heater hose against the automatic choke housing and connect the hose at the intake manifold.

8. Install the carburetor fuel inlet line and the automatic choke heat tube if so equipped.

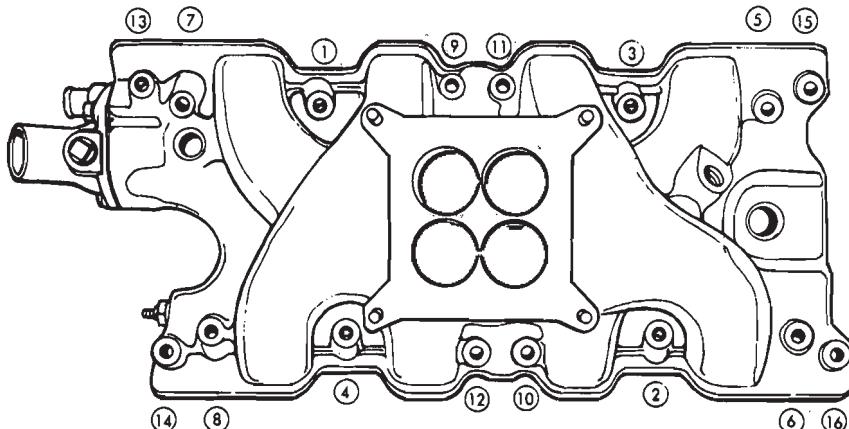
9. Rotate the crankshaft damper until the No. 1 piston is on TDC at the end of the compression stroke. Position the distributor in the block with the rotor at the No. 1 firing position and the points just open. Install the hold down clamp.

10. Install the distributor cap. Position the spark plug wires in the harness brackets on the valve rocker arm covers and connect the wires to the spark plugs.

11. Connect the crankcase vent hose. Connect the high tension lead and coil wires.



**FIG. 20—Intake Manifold Torque Sequence—351-W CID**



**FIG. 21—Intake Manifold Torque Sequence—302 BOSS**

12. Connect the accelerator rod or cable and retracting spring. On 302 BOSS engines, connect the choke cable to the carburetor.

On a vehicle with an automatic transmission, connect the transmission vacuum line.

On a vehicle equipped with vacuum-operated accessories, connect any vacuum lines that were disconnected from the intake manifold during removal.

On a vehicle with air conditioning, install the compressor to intake manifold brackets.

On 302 BOSS engines, install the Thermactor air hose on the check valve at the rear of the intake manifold. Position the hose and air bypass valve onto the hose bracket. Tighten the air hose clamps.

13. Fill and bleed the cooling system.

14. Start the engine and check and adjust the ignition timing. Connect the distributor vacuum hoses to the distributor.

15. Operate the engine at fast idle and check all hose connections and gaskets for leaks. When engine temperatures have stabilized adjust the engine idle speed and idle fuel mixture. Retorque intake manifold bolts to specifications.

16. Connect the automatic choke heat chamber air inlet hose.

17. Install the air cleaner and intake duct assembly.

## EXHAUST MANIFOLDS

### REMOVAL

1. On a right exhaust manifold, remove the air cleaner and intake duct assembly. On 302-2V and 351-W

engines, disconnect the automatic choke heat chamber air inlet hose from the inlet tube near the right valve rocker arm cover.

Remove the automatic choke heat tube.

Remove the nuts or bolts retaining the heat stove on the exhaust manifold and remove the heat stove.

2. Disconnect the exhaust manifold from the muffler inlet pipe.

3. Remove the attaching bolts and washers and remove the exhaust manifold.

## INSTALLATION

1. Clean the mating surfaces of the

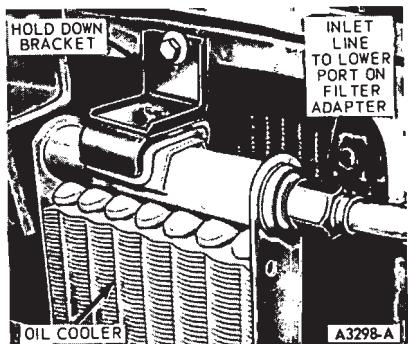


FIG. 22—Engine Oil Cooler Installed—302 BOSS Engine

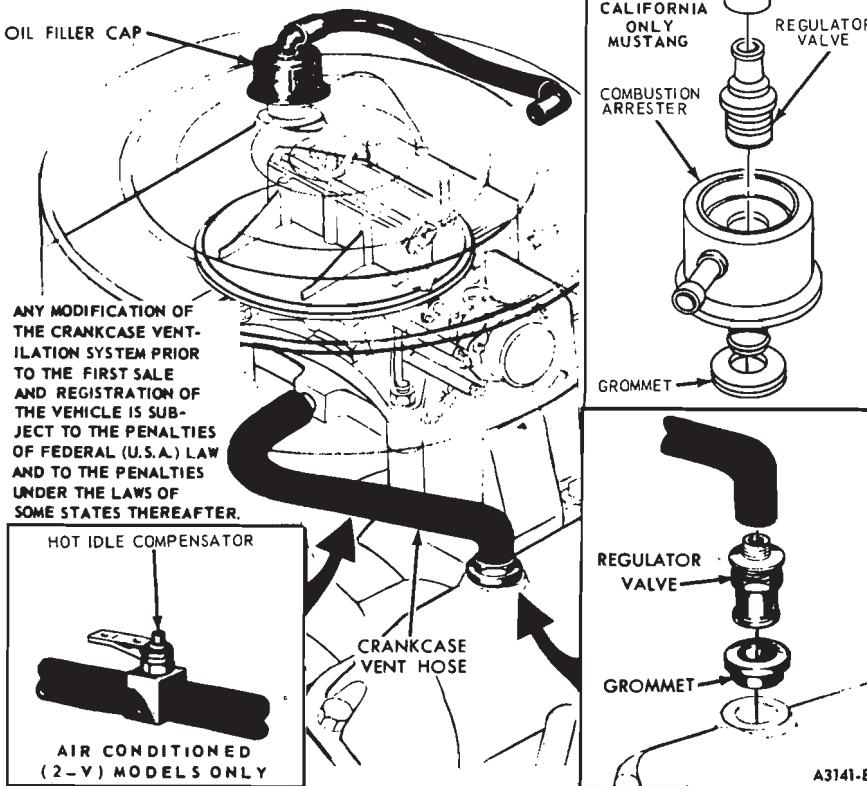


FIG. 23—Crankcase Ventilation System Components

exhaust manifold and cylinder head. Clean the mounting flange of the exhaust manifold and muffler inlet pipe.

2. Apply graphite grease to the mating surface of the exhaust manifold.

3. Position the exhaust manifold on the cylinder head and install the attaching bolts and tab washers. Working from the center to the ends, torque the bolts to specifications.

4. Position the muffler inlet pipe to the manifold. Install and torque the attaching nuts to specifications.

5. Install the automatic choke heat tube, if so equipped, and heat stove on the right exhaust manifold. Install the air cleaner and intake duct assembly.

6. Connect the automatic choke heat chamber inlet hose, if so equipped.

7. Start the engine and check for exhaust leaks.

## OIL COOLER—302 BOSS ENGINE

### REMOVAL

1. Disconnect the inlet and outlet lines from the oil cooler and drain them into a container.

2. Remove the hold-down bracket from on top of the cooler (Fig. 22).

3. Lift the cooler from the lower mount.

## INSTALLATION

1. Position the oil cooler on the lower mount.

2. Install the upper hold-down bracket.

3. Connect the inlet and outlet lines.

4. Fill the crankcase to the proper level with the specified oil.

5. Start the engine and check for oil leaks.

## CRANKCASE VENTILATION SYSTEM

The positive closed-type crankcase ventilation system components are shown in Fig. 23.

### REMOVAL

1. Remove the ventilation system air intake hose from the air cleaner and the oil filler cap.

2. Remove the air cleaner and intake duct assembly.

3. Disconnect the crankcase vent hose from the carburetor spacer, regulator valve and hot idle compensator (if so equipped).

4. Pull the regulator valve out of the valve rocker arm cover or combustion arrester mounting grommet. On vehicles equipped with a crankcase storage fuel evaporative emission system, remove the combustion arrester from the rocker arm cover.

### INSTALLATION

1. On a vehicle equipped with a crankcase storage fuel evaporative emission system, insert the combustion arrester into the valve rocker arm cover and connect the vapor line from the fuel tank.

2. Insert the regulator valve into the valve rocker arm cover or combustion arrester mounting grommet.

3. Connect the vent hose to the carburetor spacer, regulator valve and hot idle compensator (if so equipped).

4. Install the air cleaner and intake duct assembly.

5. Install the ventilation system air intake hose to the air cleaner and the oil filler cap.

6. Start the engine and check for leaks.

## CYLINDER HEADS

If a cylinder head is to be replaced, follow the procedures under Cylinder Head Disassembly and Assembly, and transfer all valves, springs, spark plugs, etc., to the new cylinder head. Clean and inspect all parts, reface the valves (refer to Part 21-01) and check all assembly clearances before assembling the new or used parts to the new cylinder head.

### REMOVAL

1. Remove the intake manifold and carburetor as an assembly following the procedure under Intake Manifold Removal.

2. Remove the rocker arm cover(s). If the left cylinder head is removed from a 302 BOSS engine, remove the ignition coil from the cylinder head.

If the left cylinder head is to be removed on a vehicle with an air conditioner, isolate and remove the compressor as outlined in Group 34.

If the left cylinder head is to be

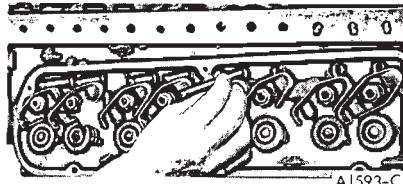


FIG. 24—Removing Valve Push Rod

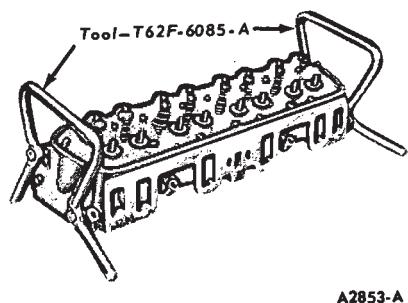


FIG. 25—Cylinder Head Holding Fixtures—302-2V and 351-W Engines

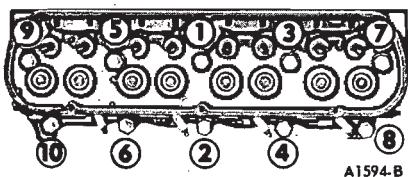


FIG. 26—Cylinder Head Bolt Torque Sequence

removed on a vehicle with power steering, disconnect the power steering pump bracket from the left cylinder head and remove the drive belt from the pump pulley. Position the power steering pump out of the way and in a position that will prevent the oil from draining out.

3. If the right cylinder head is to be removed, remove the alternator mounting bracket bolt and spacer, ignition coil and air cleaner inlet duct from the right cylinder head assembly.

4. Disconnect the exhaust manifold(s) from the muffler inlet pipe(s).

5. Loosen the rocker arm stud nuts so that the rocker arms can be rotated to the side. Remove the push rods in sequence (Fig. 24) so that they may be installed in their original positions.

On 302-2V engines remove the exhaust valve stem caps.

6. On 302-2V and 351-W engines, install the cylinder head holding fixtures (Fig. 25).

Remove the cylinder head attaching bolts and lift the cylinder head off the block. If working on a 351-W V-8, remove the exhaust manifolds to gain access to the lower attaching bolts. Remove and discard the cylinder head gasket.

### INSTALLATION

1. Clean the cylinder head, intake manifold, valve rocker arm cover and cylinder head gasket surfaces. If the cylinder head was removed for a cylinder head gasket replacement, check the flatness of the cylinder head and block gasket.

2. Position the new cylinder head gasket over the cylinder dowels on the block. Position the cylinder head on the block and install the attaching bolts. Remove the holding fixtures.

3. The cylinder head bolts are tightened in three progressive steps. Torque all the bolts in sequence (Fig. 26) to 50 ft-lbs., then to 60 ft-lbs. and finally to specifications. When cylinder head bolts have been tightened following this procedure, it is not necessary to retorque the bolts after extended operation. However, the bolts may be checked and retorqued if desired. If working on a 351-W V-8, install the exhaust manifolds and torque the attaching bolts to specification.

4. Clean the push rods in a suitable solvent. Blow out the oil passage in the push rod with compressed air. Check the ends of the push rods for nicks, grooves, roughness or excessive wear. Visually check the push rods

for straightness or check push rod runout with a dial indicator. If runout exceeds the maximum limit at any point, discard the rod. **Do not attempt to straighten push rods.**

5. Apply Lubriplate or equivalent to both ends of the push rods. Install the push rods in their original positions. Apply Lubriplate or equivalent to the valve stem tips. On 302-2V engines install the exhaust valve stem caps.

6. Install the rocker arms. On 302-2V and 351-W engines, perform a valve clearance adjustment as outlined under Valve Clearance Adjustment—Hydraulic Valve Lifters.

On 302 BOSS engines, perform a preliminary valve lash adjustment following the procedures under Valve Clearance Adjustment—Mechanical Tappet. Tighten the lock nuts to specifications.

7. Connect the exhaust manifold(s) at the muffler inlet pipe(s). Tighten the nuts to specifications.

8. If the right cylinder head was removed, install the alternator attaching bracket and air cleaner inlet duct on the right cylinder head assembly. Install the alternator (and engine identification tag on 302 CID engines). Adjust the drive belt tension to specifications.

9. Apply oil-resistant sealer to one side of new cover gasket(s). Lay the cemented side of the gasket(s) in place in the cover(s). Install the valve rocker arm cover(s).

The valve rocker cover is tightened in two steps. Tighten the bolts to specifications. Two minutes later retighten bolts to the same specifications.

10. If the left cylinder head was removed on a 302 BOSS engine, install the ignition coil.

If the left cylinder head was removed on a vehicle with an air conditioner, install the compressor as outlined in Group 34.

If the left cylinder head was removed on a vehicle with power steering, install the drive belt and power steering pump bracket. Install the bracket attaching bolts. Adjust the drive belt to specifications.

11. Install the intake manifold and related parts following the procedure under Intake Manifold Installation.

12. On 302 BOSS engines, operate the engine for 30 minutes at 1200 rpm to stabilize engine temperatures. Remove the valve rocker arm covers and perform a hot valve lash adjustment following the procedures under Valve Clearance Adjustment—Me-

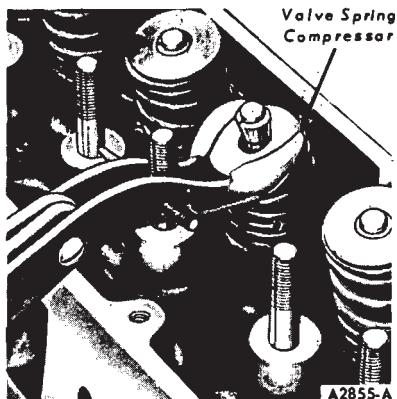


FIG. 27—Compressing Valve Spring On Bench—Typical

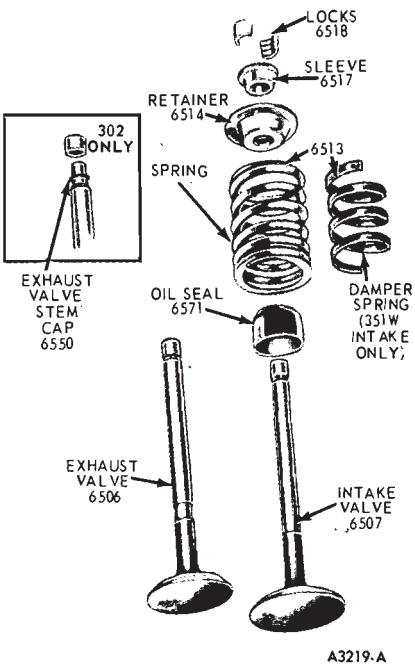


FIG. 28—Valve Assembly—302-2V and 351-W Engines

chanical Tappet. Tighten the lock nuts to specifications. Install the valve rocker covers.

#### DISASSEMBLY

1. On 302-2V engines, remove the exhaust valve stem caps.
2. Remove the exhaust manifolds (302-2V and 302 BOSS only) and the spark plugs.
3. Clean the carbon out of the cylinder head combustion chambers before removing the valves.
4. Compress the valve springs (Fig.

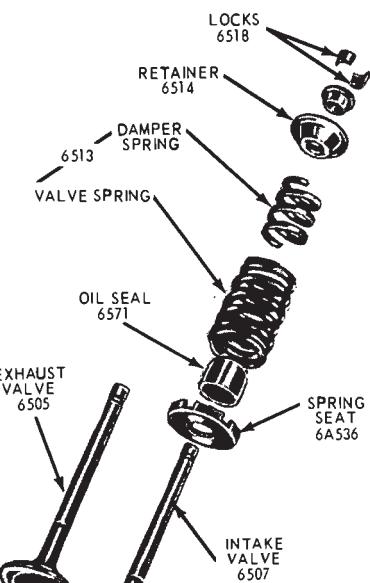


FIG. 29—Valve Assembly—302 BOSS Engines

27). Remove the spring retainer locks and release the spring.

5. On 302-2V and 351-W engines, remove the sleeve, spring retainer, spring, stem seal and valve. Discard the valve stem seals.

On 302 BOSS engines, remove the spring retainer, spring and damper spring, stem seal, spring seat and valve.

Discard the valve stem seals. Identify all valve parts.

6. Clean, inspect and repair the cylinder head as required, or transfer all usable parts to a new cylinder head.

#### ASSEMBLY

All valves, valve stems and valve guides are to be lubricated with heavy oil MS. The valve tips are to have Lubriplate or equivalent applied. The lubricant is to be applied before installation.

1. Install each valve (Figs. 28 and 29) in the port from which it was removed or to which it was fitted. On 302 BOSS engines, install the spring seat. Install a new stem seal on the valve.

2. Install the valve spring and damper, if so equipped, over the valve, and then install the spring retainer. Compress the spring and install the sleeve, if so equipped, and retainer locks (Fig. 27).

3. Measure the assembled height of the valve spring from the surface of

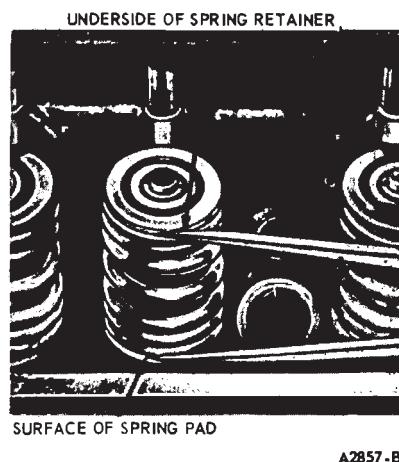


FIG. 30—Valve Spring Assembled Height

the cylinder head spring pad to the underside of the spring retainer with dividers (Fig. 30). Check the dividers against a scale. On 302 BOSS engines, subtract the thickness of the spring seat from scale reading for correct assembled height. If the assembled height is greater than specifications, install the necessary 0.030-inch thick spacer(s) between the cylinder head spring pad and the valve spring to bring the assembled height to the recommended height.

Do not install the spacers unless necessary. Use of spacers in excess of recommendations will result in overstressing the valve springs and overloading the camshaft lobes which could lead to spring breakage and/or worn camshaft lobes.

4. Install the exhaust manifolds (302-2V and 302 BOSS only) and the spark plugs.

#### VALVE SPRING, RETAINER AND STEM SEAL

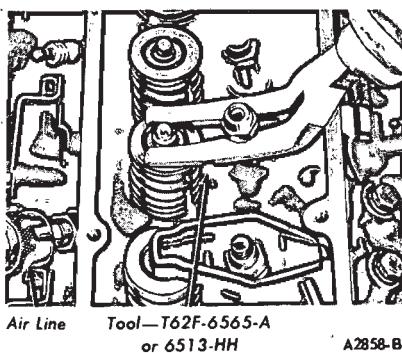
Broken valve springs or damaged valve stem seals and retainers may be replaced without removing the cylinder head, provided damage to the valve or valve seat has not occurred.

#### REMOVAL

1. Remove the valve rocker arm cover and the applicable spark plug.

2. Remove the valve rocker arm stud nuts, fulcrum seats, valve rocker arms and push rods from the applicable cylinder. On 302 CID engines, remove the exhaust valve stem caps.

3. Install an air line with an adapter in the spark plug hole and turn on the air supply.



**FIG. 31—Compressing Valve Spring—In Chassis**

4. Install the stud nut and position the compressor tool as shown in Fig. 31. On 302-2V and 351-W engines, compress the valve spring and remove the retainer locks, sleeve, spring retainer and valve spring.

On 302 BOSS engines, compress the valve spring and remove the retainer lock, spring retainer and valve spring and damper assembly.

5. Remove and discard the valve stem seal (Fig. 32).

6. If air pressure has forced the piston to the bottom of the cylinder, any removal or air pressure will allow the valve(s) to fall into the cylinder. A rubber band, tape or string wrapped around the end of the valve stem will prevent this condition and will still allow enough travel to check the valve for binds.

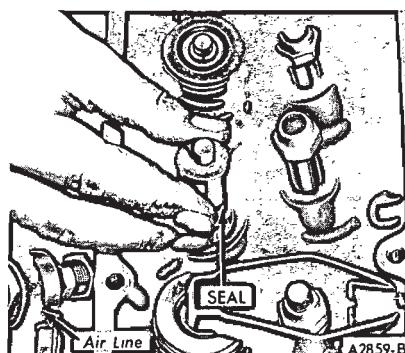
## INSTALLATION

1. Inspect the valve stem for damage. Rotate the valve and check the valve stem tip for eccentric movement during rotation. Move the valve up and down through normal travel in the valve guide and check the stem for binds. If the valve has been damaged, it will be necessary to remove the cylinder head for repairs as outlined in Part 21-01, Section 2.

2. If the condition of the valve proved satisfactory, apply heavy engine oil MS to the valve stem and hold the valve in the closed position. Apply the air pressure within the cylinder.

3. Install a new valve stem seal (Fig. 32). Place the spring and damper, if so equipped, in position over the valve and install the valve spring retainer and sleeve, if so equipped. Compress the valve spring and install the valve spring retainer locks. Remove the compressor tool and stud nut.

4. Apply Lubriplate or equivalent



**FIG. 32—Removing or Installing Valve Stem Seal**

on both ends of the push rod. Install the push rod. Apply Lubriplate or equivalent to the tip of the valve stem. On exhaust valves, install the valve stem cap, if so equipped.

5. Apply Lubriplate, or equivalent, to the push rod socket, fulcrum seat and the valve pad of the rocker arm; then install the valve rocker arms, fulcrum seats and stud nuts.

6. On 302-2V and 351-W engines, adjust the valve clearance following the procedure under Valve Clearance Adjustment—Hydraulic Valve Lifters.

On 302 BOSS engines perform a preliminary valve lash adjustment following the procedure under Valve Clearance Adjustment—Mechanical Tappet. Tighten the stud lock nut to specifications.

7. Turn off the air and remove the air line and adapter. Install the spark plug and connect the spark plug wire.

8. Clean and install the rocker arm cover.

If the right cover was removed on a 302-2V or 351-W engine, install the automatic choke heat tube and the crankcase ventilation regulator valve. Connect the automatic choke heat chamber air inlet hose.

9. Install the air cleaner and intake duct assembly

10. On 302 BOSS engines, operate the engine for 30 minutes at 1200 rpm to stabilize engine temperatures. Remove the valve rocker arm covers and perform a hot valve lash adjustment following procedures under Valve Clearance Adjustment—Mechanical Tappet. Tighten the stud lock nuts to specification.

Install the valve rocker arm covers.

## WATER PUMP REMOVAL

1. Drain the cooling system

On vehicles equipped with a fan shroud, remove the shroud attaching bolts and position the shroud over the

fan.

Remove the fan and spacer from the water pump shaft. Remove the shroud if so equipped.

2. Remove the air conditioner drive belt and idler pulley bracket if so equipped.

Remove the alternator drive belt.

Remove the power steering drive belt and power steering pump, if so equipped.

Remove all accessory brackets which attach to the water pump. Remove the water pump pulley.

3. Disconnect the radiator lower hose, heater hose and water pump by-pass hose at the water pump.

4. Remove the bolts that attach the pump to the cylinder front cover. Remove the pump and gasket. Discard the gasket.

## INSTALLATION

Before a water pump is re-installed, check it for damage. If it is damaged, replace it.

1. Remove all gasket material from the mounting surfaces of the cylinder front cover and water pump.

2. Position a new gasket, coated on both sides with sealer, on the cylinder front cover; then install the pump.

3. Install the attaching bolts and torque them to specifications.

4. Connect the radiator hose, heater hose and water pump by-pass hose at the water pump.

5. Install all the accessory brackets which attach to the water pump. Place the water pump pulley on the water pump shaft.

6. Install the power steering pump and drive belt if so equipped. Install the alternator and drive belt. Install the air conditioner idler pulley bracket and drive belt if so equipped.

7. Position the fan shroud, if so equipped, over the water pump pulley and install the spacer or fan drive clutch and fan. Install the shroud attaching bolts.

Adjust the drive belts to the specified belt tension.

8. Fill and bleed the cooling system. Operate the engine until normal operating temperatures have been reached and check for leaks.

## CYLINDER FRONT COVER AND TIMING CHAIN

### REMOVAL

1. Drain the cooling system and the crankcase.

2. On vehicles equipped with a fan

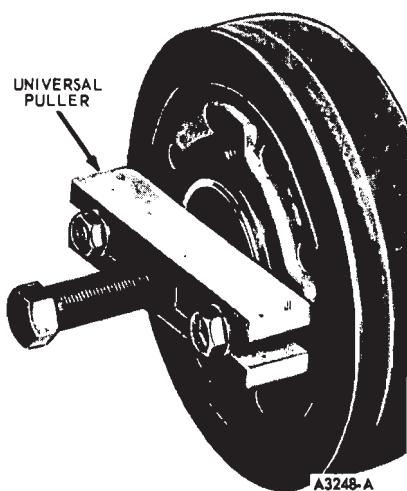


FIG. 33—Removing Crankshaft Vibration Damper

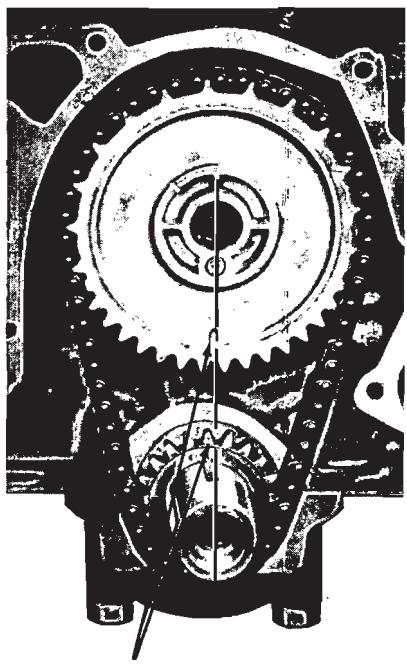


FIG. 34—Aligning Timing Marks

shroud, remove the shroud attaching bolts and position the shroud rearward.

Remove the bolts attaching the fan and spacer to the water pump and remove the fan and spacer or fan drive clutch from the water pump shaft. Remove the fan shroud, if so equipped.

3. Remove the air conditioner drive belt and idler pulley bracket if so equipped.

Remove the alternator and drive belt.

Remove the power steering pump drive belt and power steering pump if so equipped.

On 302 BOSS engines remove the Thermactor air pump and drive belt.

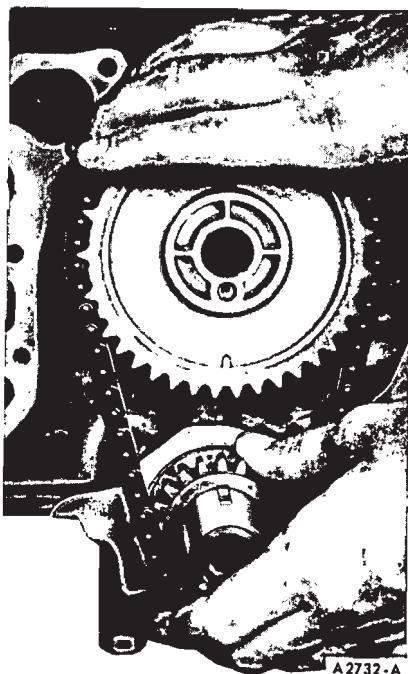


FIG. 35—Removing or Installing Timing Chain

4. Remove the water pump pulley.
5. Disconnect the heater hose, radiator hose and water pump by-pass hose at the water pump.

6. Remove the crankshaft pulley from the crankshaft vibration damper. Remove the damper attaching screw and washer. Install the puller on the crankshaft vibration damper (Fig. 33) and remove the vibration damper.

7. Disconnect the fuel pump outlet line from the fuel pump. Remove the fuel pump attaching bolts and lay the pump to one side with the flexible fuel line still attached.

8. Remove the oil level dipstick.

9. Remove the oil pan to cylinder front cover attaching bolts. Use a thin blade knife to cut the oil pan gasket flush with cylinder block face prior to separating the cover from the cylinder block. Remove the cylinder front cover and water pump as an assembly.

If a new cylinder front cover is to be installed, remove the water pump and dipstick tube from the old cylinder front cover and install them on the new cover.

10. Discard the cylinder front cover gasket. Remove the crankshaft front oil slinger.

11. Check the timing chain deflection (refer to Part 21-01, Section 1).

12. Crank the engine until the timing marks on the sprockets are positioned as shown in Fig. 34.

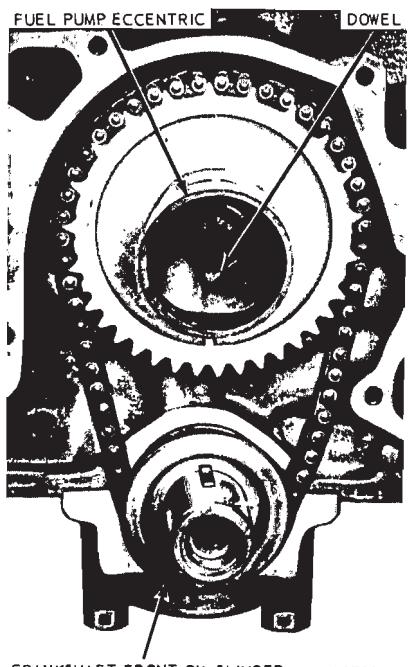


FIG. 36—Fuel Pump Eccentric and Front Oil Slinger Installed

13. Remove the camshaft sprocket cap screw, washers and fuel pump eccentric. Slide both sprockets and the timing chain forward, and remove them as an assembly (Fig. 35).

## INSTALLATION

1. Position the sprockets and timing chain on the camshaft and crankshaft simultaneously (Fig. 35). Be sure the timing marks on the sprockets are positioned as shown in Fig. 34.

2. Install the fuel pump eccentric, washers and camshaft sprocket cap screw. Torque the sprocket cap screw to specifications. Install the crankshaft front oil slinger (Fig. 36).

3. Clean the cylinder front cover, oil pan and the block gasket surfaces.

4. Install a new oil seal in the cylinder front cover following the procedures under Front Oil Seal Removal and Installation.

5. Lubricate the timing chain with engine oil.

6. Coat the gasket surface of the oil pan with sealer, cut and position the required sections of a new gasket on the oil pan, apply sealer at the corners. Install pan seal as required.

- Coat the gasket surfaces of the block and cover with sealer, and position a new gasket on the block.

7. Position the cylinder front cover on the cylinder block. Use care when installing the cover to avoid seal dam-

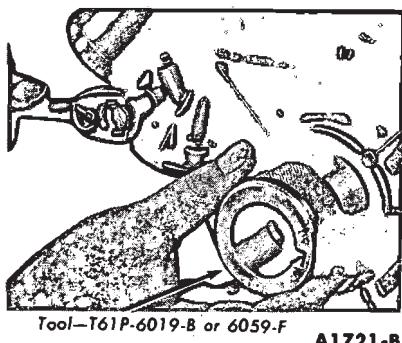


FIG. 37—Aligning Cylinder Front Cover

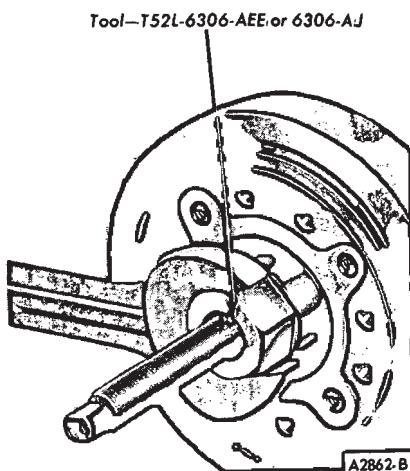


FIG. 38—Installing Crankshaft Vibration Damper

age or possible gasket mislocation.

8. Install the cylinder front cover to seal alignment tool into proper position.

9. It may be necessary to force the cover downward in a manner to slightly compress the pan gasket. This operation can be facilitated by using a suitable tool at the front cover attaching hole locations.

10. Coat the threads of the attaching screws with oil resistant sealer and install the screws. While pushing in on the alignment tool, tighten the oil pan to cover attaching screws to specifications (Fig. 37). Tighten the cover to block attaching screws to specifications. Remove the pilot.

11. Apply Lubriplate or equivalent to the oil seal rubbing surface of the vibration damper inner hub to prevent damage to the seal. Apply a white lead and oil mixture to the front of the crankshaft for damper installation.

12. Line up the crankshaft vibration damper keyway with the key on the crankshaft. Install the vibration

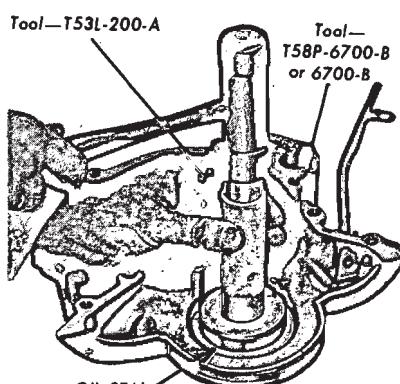


FIG. 39—Installing Crankshaft Front Oil Seal

damper on the crankshaft (Fig. 38). Install the cap screw and washer. Tighten the screw to specifications. Install the crankshaft pulley.

13. Install the fuel pump using a new gasket. Connect the fuel pump outlet line.

14. Install the oil level dipstick.

15. Connect the radiator hose, heater hose and water pump by-pass hose at the water pump.

16. Install the water pump pulley on the water pump shaft.

17. On 302 BOSS engines install the Thermactor air pump and drive belt.

Install the power steering pump and drive belt if so equipped.

Install the alternator and drive belt.

Install the air conditioner idler pulley and drive belt if so equipped.

18. Position the fan shroud over the water pump pulley if so equipped.

Install the fan and spacer or fan clutch drive. Install the fan shroud attaching bolts if so equipped.

19. Adjust all drive belts to the specified tension.

20. Fill the crankcase with the proper grade and quantity of engine oil.

21. Fill and bleed the cooling system.

22. Operate the engine at fast idle and check for coolant and oil leaks. Check and adjust the ignition timing.

## FRONT OIL SEAL

### REMOVAL

1. Remove the cylinder front cover following the procedure under Cylinder Front Cover and Timing Chain Removal.

2. Drive out the old seal with a pin punch. Clean out the recess in the cover.

### INSTALLATION

1. Coat a new seal with grease, then install the seal in the cover. Drive the seal in until it is fully seated in the recess (Fig. 39). Check the seal after installation to be sure the spring is properly positioned in the seal.

2. Replace the cylinder front cover following the procedure under Cylinder Front Cover and Timing Chain Installation.

## CAMSHAFT

The camshaft and related parts are shown in Fig. 40.

### REMOVAL

1. Disconnect the upper and lower radiator hoses. Disconnect the transmission oil cooler lines from the radiator, if so equipped. Remove the bolts retaining the fan shroud to the radiator, if so equipped. Remove the radiator.

On vehicles equipped with air conditioning, remove the bolts which secure the air conditioner condenser and position the condenser out of the way.

2. Remove the cylinder front cover and the timing chain following the procedure under Cylinder Front Cover and Timing Chain Removal.

3. Remove the intake manifold and related parts by following procedures under Intake Manifold Removal.

4. Remove the crankcase ventilation valve from the valve rocker arm cover. Remove the valve rocker arm covers. Loosen the valve rocker arm stud nuts and rotate the rocker arms to the side.

5. Remove the valve push rods and identify them so that they can be installed in their original positions.

6. Using a magnet, remove the valve lifters and place them in a rack so that they can be installed in their original bores (Fig. 41).

If the valve lifters are stuck in their bores by excessive varnish, etc., it may be necessary to use a plier-type tool (T52T-6500-DJD or 6500-D) or a claw type tool to remove the lifters. Rotate the lifter back and forth to loosen it from the gum or varnish that may have formed at the lifter.

7. Remove the camshaft thrust plate. Carefully remove the camshaft by pulling toward the front of the en-

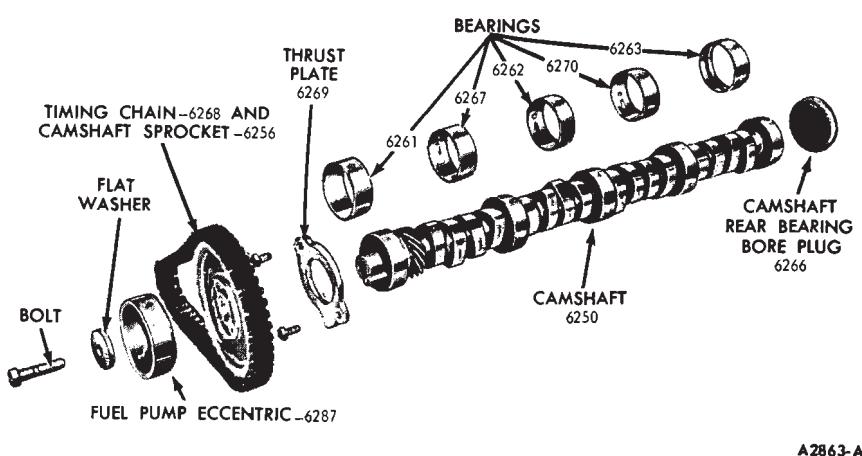


FIG. 40—Camshaft and Related Parts

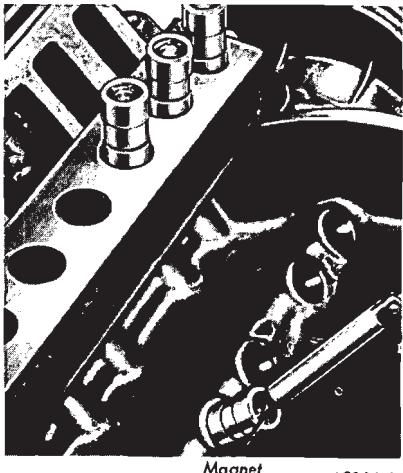


FIG. 41—Removing Valve Lifter

gine. Use caution to avoid damaging the camshaft bearings.

## INSTALLATION

Camshaft lobes are to be coated with Lubriplate or equivalent and the journals lubricated with heavy oil MS before installation.

1. Oil the camshaft journals with heavy engine oil MS and apply Lubriplate or equivalent to the lobes. Carefully slide the camshaft through the bearings. Install the camshaft thrust plate with groove towards the cylinder block. Check camshaft end play as shown in Part 21-01, Section 1.

2. Lubricate the lifters and bores with heavy engine oil MS. Install the valve lifters in the bores from which they were removed.

3. Apply Lubriplate or equivalent to each end of the push rods and install the push rods in their original positions. Apply Lubriplate or equivalent to the valve stem tips. Lubricate

the rocker arms and fulcrum seats with heavy engine oil MS. Position the rocker arms over the push rods.

4. Install the intake manifold and related parts by following procedures under Intake Manifold Installation.

5. Connect the water temperature sending unit and the engine ground strap.

6. Connect the accelerator rod and retracting spring.

7. Connect the heater hose at the intake manifold. Position and connect the fuel line.

8. Replace the crankshaft front oil seal following procedures under Front Oil Seal Removal and Installation. Install the timing chain, cylinder front cover and related parts following procedures under Cylinder Front Cover and Timing Chain Installation.

9. On vehicles equipped with air conditioning, install the air conditioning condenser.

Position the fan shroud, if so equipped, over the fan. Install the radiator and connect the upper and lower radiator hoses.

On a vehicle equipped with an automatic transmission, connect the transmission oil cooler lines.

Install the fan shroud retaining screws if so equipped.

10. With No. 1 piston on TDC at the end of the compression stroke, position the distributor in the block with the rotor at the No. 1 firing position and the points just open. Install the hold down clamp.

11. On 302-2V and 351-W engines perform a valve clearance adjustment as outlined under Valve Clearance Adjustment—Hydraulic Valve Lifters.

On 302 BOSS engines, perform a preliminary valve lash adjustment following the procedure under Valve

## Clearance Adjustment—Mechanical Tappet.

12. Clean the valve rocker arm covers and the cylinder head gasket surface. Apply oil-resistance sealer to one side of new cover gaskets. Lay the cemented side of the gaskets in place in the covers.

13. Position the covers on the cylinder heads. Make sure the gasket seats evenly all around the head. Install the bolts. The cover is tightened in two steps. Torque the bolts to specifications. Two minutes later, torque the bolts to the same specifications.

14. Clean and install the crankcase ventilation system.

15. Install the automatic choke heat tube if so equipped. Connect the ignition coil wires.

16. Install the distributor cap. Position the spark plug wires in the harness brackets on the valve rocker arm covers and connect the wires to the plugs. Connect the high tension lead at the coil.

17. Fill and bleed the cooling system. Fill the crankcase with the proper grade and quantity of engine oil.

18. Start the engine and check and adjust the ignition timing. Connect the distributor vacuum line at the carburetor.

19. Operate the engine at fast idle and check all hose connections and gaskets for leaks. When the engine temperature has stabilized adjust the engine idle speed and idle fuel mixture.

On 302 BOSS engines, remove the valve rocker arm covers and perform a hot valve lash adjustment with the engine idling following procedures under Valve Clearance Adjustment—Mechanical Tappet.

20. Adjust the transmission throttle linkage. Install the air cleaner and intake duct assembly.

21. Connect the automatic choke heat chamber air inlet hose.

## CAMSHAFT REAR BEARING BORE PLUG

### REMOVAL

1. On a vehicle with a manual-shift transmission, remove the transmission, clutch pressure plate and disc following the procedures in Group 16.

On a vehicle with an automatic transmission, remove the transmission and converter housing following the procedure in Group 17.

2. Remove the flywheel attaching

bolts and remove the flywheel. Remove the engine rear cover plate.

3. Remove the core plug as detailed in Part 21-01, Section 2.

## INSTALLATION

1. Install the core plug as detailed in Part 21-01, Section 2.

2. Coat the flywheel attaching bolts with oil-resistant sealer. Position the engine rear cover plate on the cylinder block dowels. Position the flywheel on the crankshaft flange. Install and torque the attaching bolts in sequence across from each other to specifications.

On a vehicle with a manual-shift transmission, install the clutch pressure plate, disc and the transmission following the procedures in Group 16.

On a vehicle with an automatic transmission, install the transmission and converter housing following the procedure in Group 17.

## VALVE LIFTER REPLACEMENT

Before replacing a hydraulic valve lifter for noisy operation, be sure the noise is not caused by improperly adjusted valve lash or by worn rocker arms or push rods.

### REMOVAL

1. Remove the intake manifold and related parts by following procedures under Intake Manifold Removal.

2. Remove the crankcase ventilation regulator valve from the valve rocker arm cover.

3. Remove the valve rocker arm covers. Loosen the valve rocker arm stud nuts and rotate the rocker arms to the side.

4. Remove the valve push rods and identify them so that they can be installed in their original positions.

5. Using a magnet, remove the valve lifters and place them in a rack so that they can be installed in their original bores (Fig. 41).

If the valve lifters cannot be removed from their bores due to excessive varnish, etc., it may be necessary to use a plier-type tool (T52T-6500-DJD or 6500-D) or a claw type tool to remove the lifters. Rotate the lifter back and forth to loosen it from the gum or varnish that may have formed at the lifter.

## INSTALLATION

Tappets or lifters and bores are to be lubricated with heavy oil MS before installation.

1. Clean and install the valve lifters

in the bores from which they were removed. If a new lifter(s) is being installed, check the new lifter(s) for a free fit in the bore in which it is to be installed. Lubricate the lifter(s) and bore(s) with heavy engine oil MS before inserting it in the bore.

2. Install the push rods in their original position. Apply Lubriplate or equivalent to the valve stem tips and the push rod guides in the cylinder head.

3. Lubricate the rocker arms and fulcrum seats with heavy engine oil MS. Position the rocker arms over the push rods. On 302-2V and 351-W engines, perform a valve clearance adjustment as outlined under Valve Clearance Adjustment—Hydraulic Valve Lifters.

On 302 BOSS engines, perform a preliminary valve lash adjustment following procedures under Valve Clearance Adjustment—Mechanical Tappet.

4. Install the valve rocker arm covers. Install the crankcase ventilation regulator valve in the valve rocker arm cover.

5. Install the intake manifold and related parts by following procedures under Intake Manifold Installation.

6. On 302 BOSS engines, operate the engine for 30 minutes at 1200 rpm to stabilize engine temperatures. Remove the valve rocker arm covers and perform a hot valve lash adjustment with the engine idling following procedures under Valve Clearance Adjustment—Mechanical Tappet. Install the valve rocker arm covers.

## VALVE LIFTER DISASSEMBLY

The internal parts of each hydraulic valve lifter assembly are matched sets. Do not intermix the parts. Keep the assemblies intact until they are to be cleaned.

The disassembly and assembly procedures for Types I and II valve lifters are different. Valve lifters should always be tested after assembly; refer to the test procedures covered in Part 21-01, Section 1.

### TYPE I

#### Disassembly

Disassemble and assemble each lifter separately. Identify the lifter assemblies so they can be installed in their original bores.

1. Grasp the lock ring with needle nose pliers to release it from the groove. It may be necessary to de-

press the plunger to fully release lock ring.

2. Remove the push rod cup, metering valve (disc), plunger and spring.

3. Remove the plunger assembly, the check valve and the check valve retainer and plunger spring. Carefully remove the plunger spring, the check valve retainer and, the check valve disc from the plunger.

### Assembly

Type I hydraulic lifter assembly is shown in Fig. 42.

1. Place the plunger upside down on a clean work bench.

2. Place the check valve (disc or ball check) in position over the oil hole on the bottom of the plunger. Set the check valve spring on top of the check valve (disc or ball check).

3. Position the check valve retainer over the check valve and spring and push the retainer down into place on the plunger.

4. Place the plunger spring, and then the plunger (open end up) into the lifter body.

5. Position the metering valve (disc) in the plunger, and then place the push rod cup in the plunger.

6. Depress the plunger, and position the closed end of the lock ring in the groove of the lifter body. With the plunger still depressed, position the open ends of the lock ring in the groove. Release the plunger, and then depress it again to fully seat the lock ring.

7. Use the hydraulic valve lifter leakdown tester (Part 21-01) to fill the lifters with test fluid.

### TYPE II

#### Disassembly

Each valve lifter is a matched

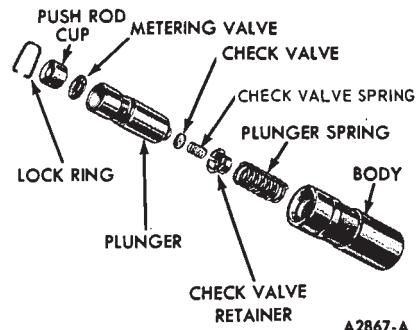


FIG. 42—Type I Hydraulic Valve Lifter Assembly

assembly. If parts of one lifter are intermixed with those of another, improper valve operation may result. Disassemble and assemble each lifter separately. Keep the lifter assemblies in proper sequence so they can be installed in their original bores.

1. Grasp the lock ring with needle nose pliers to release it from the groove. It may be necessary to depress the plunger to fully release lock ring.

2. Remove the push rod cup, metering valve disc, and the upper metering valve. Do not bend the metering valve or the valve tensioning

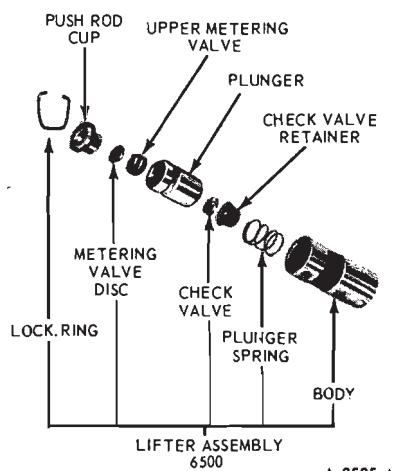


FIG. 43—Type II Hydraulic Valve Lifter Assembly

finger.

3. Remove the plunger assembly, the check valve and the check valve retainer and plunger spring. Carefully remove the plunger spring, the check valve retainer and the check valve disc from the plunger.

#### Assembly

Type II hydraulic lifter assembly is shown in Fig. 43.

1. Place the plunger on a clean work surface (table or bench) in an inverted position and center the check valve disc on it. Carefully slide the check valve over the disc and down until it bottoms. A slight turning motion will help this. Use every precaution not to distort it in anyway, or to bend the preformed fingers. With a slight turning motion slide the plunger spring over the metering valve and down until it seats.

2. Leaving the assembly in the inverted position, slide the lifter body down over the spring until it slightly compresses the spring.

3. Position the combined assembly right side up on the work surface (table or bench).

4. Position the upper metering valve in the plunger taking care not to tilt it to either side, and not to damage or bend the valve tensioning finger. Place the metering valve disc over the metering valve and install the push rod cup. Depress the cup and install the lock ring.

5. Use the hydraulic valve lifter leakdown tester (Part 21-01) to fill the lifters with test fluid.

#### CRANKSHAFT REAR OIL SEAL REPLACEMENT

Replacement of a crankshaft rear oil seal because of oil leakage requires replacement of both the upper and lower seals. Refer to Crankshaft Rear Oil Seal Replacement in Part 21-01 for replacement procedures.

#### MAIN BEARING

The main bearing inserts are selective fit. Refer to procedures under Fitting Main and Connecting Rod Bearings in Part 21-01.

#### REMOVAL

1. Drain the crankcase. Remove the oil level dipstick. Remove the oil pan and related parts.

2. Remove the oil pump inlet tube assembly and the oil pump.

On 302 BOSS engines, remove the oil baffle tray from the main bearing caps.

3. Replace one bearing at a time, leaving the other bearings securely fastened. Remove the main bearing cap to which new bearings are to be installed.

4. Insert the upper bearing removal tool (tool 6331) in the oil hole in the crankshaft.

5. Rotate the crankshaft in the direction of the engine rotation to force the bearing out of the block.

6. If the rear main bearing is being replaced, remove and discard the rear oil seal from the bearing cap.

Loosen all main bearing bolts, thereby lowering the crankshaft slightly but not to exceed  $1/32$  inch. Remove the block half of the rear oil seal. Use a seal removal tool, or install a small metal screw in one end of the seal, and pull on the screw to remove the seal. Be careful not to burr the crankshaft seal rubbing surface.

#### INSTALLATION

1. If the rear main bearing is being replaced clean the rear oil seal groove in the block with a brush and solvent.

Carefully install the upper seal (split lip type) into its groove with the undercut side of the seal toward the FRONT of the engine (Fig. 44) by rotating it on the seal journal of the crankshaft until approximately  $3/8$  inch protrudes below the parting sur-

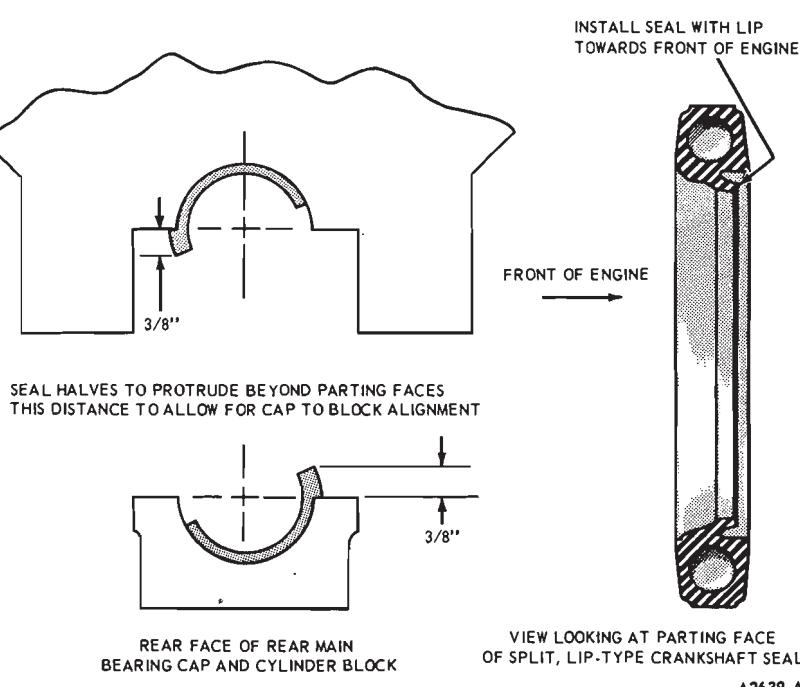


FIG. 44—Installing Crankshaft Rear Oil Seal

face.

**Be sure no rubber has been shaved from the outside diameter of the seal by the bottom edge of the groove.**

Tighten the bolts on main bearings 1, 2, 3, and 4, thereby raising the crankshaft to its original position. Torque the bolts to specifications.

2. Clean the crankshaft journals. Inspect the journals and thrust faces (thrust bearing) for nicks, burrs, or bearing pick-up that would cause premature bearing wear.

3. To install the upper main bearing, place the plain end of the bearing over the shaft on the locking tang side of the block and partially install the bearing so that tool 6331 can be inserted in the oil hole in the crankshaft. With tool 6331 positioned in the oil hole in the crankshaft, rotate the crankshaft in the opposite direction of engine rotation until the bearing seats itself. Remove the tool.

4. Replace the cap bearing.

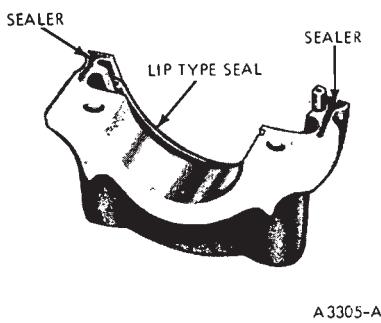
5. Select fit the bearing for proper clearance following procedures under Fitting Main and Connecting Rod Bearings in Part 21-01.

6. If the bearing is being replaced on journal number 1, 2 or 4, apply a light coat of engine oil to the journal and bearings and install the bearing cap. Tighten the cap bolts to specifications.

7. If the rear main bearing is being replaced, clean the oil seal groove with a brush and solvent.

Remove the oil seal retaining pin from the bearing cap, if so equipped. The pin is not used with the split lip seal.

8. Install the lower seal in the rear main bearing cap with undercut side of seal toward the FRONT of the engine (Fig. 44), allow the seal to protrude approximately 3/8 inch above the parting surface to mate with the upper seal when the cap is installed.



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FIG. 45—Sealer Application to Rear Main Bearing Cap

9. Apply a thin coating of oil-resistant sealer to the rear main bearing cap at the rear of the top mating surface (Fig. 45). Do not apply sealer to the area forward of the oil slinger groove. Lubricate the journal with engine oil and install the rear main bearing cap. Torque the cap bolts to specifications.

10. If the thrust bearing cap (No. 3 main bearing) has been removed, install it as follows:

Lubricate the journal with engine oil and install the thrust bearing cap with the bolts finger-tight. Pry the crankshaft forward against the thrust surface of the upper half of the bearing (Fig. 62). Hold the crankshaft cap to the rear. This will align the thrust surfaces of both halves of the bearing. Retain the forward pressure on the crankshaft. Torque the cap bolts to specifications.

11. On 302 BOSS engines, install the oil baffle tray on the main bearing caps.

12. Clean the oil pump inlet tube screen. Prime by filling the inlet opening with oil and rotate the pump shaft until oil emerges from the outlet opening. Install the oil pump and the inlet tube assembly.

13. Position the oil pan gaskets on the oil pan. Position the oil pan front seal on the cylinder front cover. Position the oil pan rear seal on the rear main bearing cap. Install the oil pan and related parts. Install the oil level dipstick.

14. Fill the crankcase. Start the engine and check for oil pressure. Operate the engine at fast idle and check for oil leaks.

## CONNECTING ROD BEARINGS

The connecting rod bearings are selective fit. Refer to procedures under Fitting Main and Connecting Rod Bearings in Part 21-01.

## REMOVAL

1. Drain the crankcase. Remove the oil level dipstick. Remove the oil pan and related parts.

2. Remove the oil pump inlet tube assembly and the oil pump.

On 302 BOSS engines, remove the oil baffle tray from the main bearing cap bolts.

3. Turn the crankshaft until the connecting rod to which new bearings are to be fitted is down. Remove the connecting rod cap. Remove the bearing inserts from the rod and cap.

## INSTALLATION

1. Be sure the bearing inserts and the bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause a failure.

2. Clean the crankshaft journal.

3. Install the bearing inserts in the connecting rod and cap with the tangs fitting in the slots provided.

4. Pull the connecting rod assembly down firmly on the crankshaft journal.

5. Select fit the bearing following procedures under Fitting Main and Connecting Rod Bearings in Part 21-01.

6. After the bearing has been fitted, clean and apply a light coat of engine oil to the journal and bearings. Install the connecting rod cap. Tighten the nuts to specifications.

7. Clean the oil pump inlet tube screen. Prime by filling the inlet opening with oil and rotate the pump shaft until oil emerges from the outlet opening. Install the oil pump and the inlet tube assembly.

On 302 BOSS engines, install the oil baffle tray onto the main bearing cap bolts.

8. Position the oil pan gaskets on the oil pan. Position the oil pan front seal on the cylinder front cover. Position the oil pan rear seal on the rear main bearing cap. Install the oil pan and related parts. Install the oil level dipstick.

9. Fill the crankcase. Start the engine and check for oil pressure. Operate the engine at fast idle and check for oil leaks.

## PISTONS AND CONNECTING RODS

## REMOVAL

1. Drain the cooling system and the crankcase. Remove the intake manifold, cylinder heads, oil pan and oil pump, following the procedures in this section.

2. On 302 BOSS engines, remove the oil baffle tray from the main bearing cap bolts.

3. Remove any ridges and/or deposits from the upper end of the cylinder bores as follows:

Turn the crankshaft until the piston to be removed is at the bottom of its travel and place a cloth on the piston head to collect the cuttings. Remove any ridge and/or deposits from the upper end of the cylinder bores. Remove the cylinder ridge with a ridge

cutter. Follow the instructions furnished by the tool manufacturers. **Never cut into the ring travel area in excess of 1/32 inch when removing ridges.**

4. Make sure all connecting rod caps are marked so that they can be installed in their original positions.

5. Turn the crankshaft until the connecting rod being removed is down.

6. Remove the connecting rod nuts and cap.

7. Push the connecting rod and piston assembly out the top of the cylinder with the handle end of a hammer. **Avoid damage to the crankshaft journal or the cylinder wall when removing the piston and rod.**

8. Remove the bearing inserts from the connecting rod and cap.

9. Install the cap on the connecting rod from which it was removed.

## INSTALLATION

1. If new piston rings are to be installed, remove the cylinder wall glaze. Follow the instructions of the tool manufacturer.

2. Oil the piston rings, pistons and cylinder walls with light engine oil. **Be sure to install the pistons in the same cylinders from which they were removed or to which they were fitted. The connecting rod and bearing caps are numbered from 1 to 4 in the right bank and from 5 to 8 in the left bank, beginning at the front of the engine. The numbers on the connecting rod and bearing cap must be on the same side when installed in the cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and the connecting rod should be numbered to correspond with the new cylinder number.**

3. Make sure the ring gaps are properly spaced around the circumference of the piston (Fig. 46).

4. Install a piston ring compressor on the piston and push the piston in with a hammer handle until it is slightly below the top of the cylinder (Fig. 47). Be sure to guide the connecting rods to avoid damaging the crankshaft journals. **Install the piston with the indentation notch in the piston head toward the front of the engine.**

5. Check the clearance of each bearing following the procedure under Fitting Main and Connecting Rod Bearings in Part 21-01.

6. After the bearings have been fitted, apply a light coat of engine oil to the journals and bearings.

7. Turn the crankshaft throw to the bottom of its stroke. Push the piston all the way down until the connecting rod bearing seats on the crankshaft journal.

8. Install the connecting rod cap. Tighten the nuts to specifications.

9. After the piston and connecting rod assemblies have been installed, check the side clearance between the connection rods on each crankshaft journal (Fig. 48).

10. On 302 BOSS engines, install the oil baffle tray on the main bearing cap bolts. Torque the four allen screws to specification.

11. Disassemble, clean, and assemble the oil pump. Clean the oil pump inlet tube screen and the oil pan and block gasket surfaces.

12. Prime the oil pump by filling either the inlet port or outlet port with engine oil and rotating the pump shaft to distribute the oil within the housing. Install the oil pump and the oil pan.

13. Install the cylinder heads following procedures under Cylinder Head Installation.

14. Install the intake manifold following procedures under Intake Manifold Installation.

15. Fill and bleed the cooling system. Fill the crankcase with the proper grade and quantity of engine oil.

16. Start the engine and check and adjust the ignition timing. Connect the distributor vacuum hoses at the carburetor.

17. Operate the engine at fast idle and check for oil and coolant leaks. When the engine temperature has stabilized adjust the engine idle speed and idle fuel mixture.

On 302 BOSS engines, remove the valve rocker arm covers and perform a hot valve lash adjustment following procedures under Valve Clearance Adjustment—Mechanical Tappet. Install the valve rocker arm covers.

18. Install the air cleaner and intake duct assembly.

19. Connect the automatic choke heat chamber air inlet hose.

## DISASSEMBLY

1. Remove the bearing inserts from the connecting rod and cap.

2. Mark the pistons and pins to assure assembly with the same rod and installation in the same cylinders from which they were removed.

3. Remove the piston rings. Using an Arbor Press and the tool shown in Fig. 49 press the piston pin from the

piston and connecting rod.

## ASSEMBLY

The piston, connecting rod and related parts are shown in Fig. 50. **Check the fit of a new piston in the cylinder bore before assembling the**

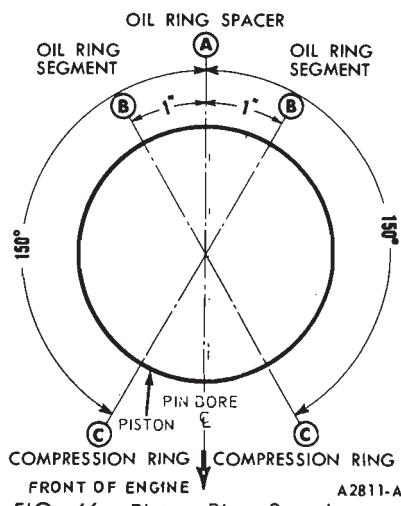


FIG. 46—Piston Ring Spacing

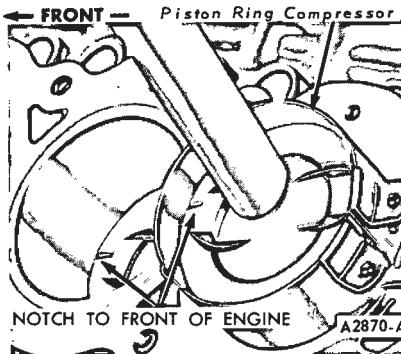


FIG. 47—Installing Piston

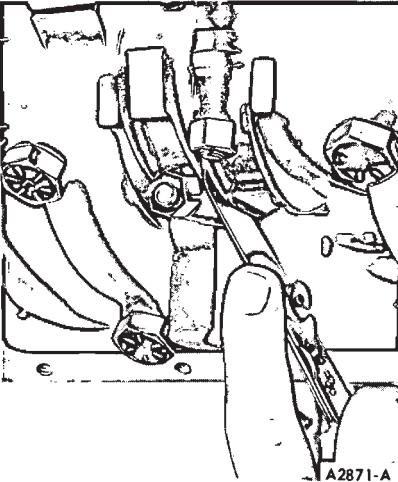
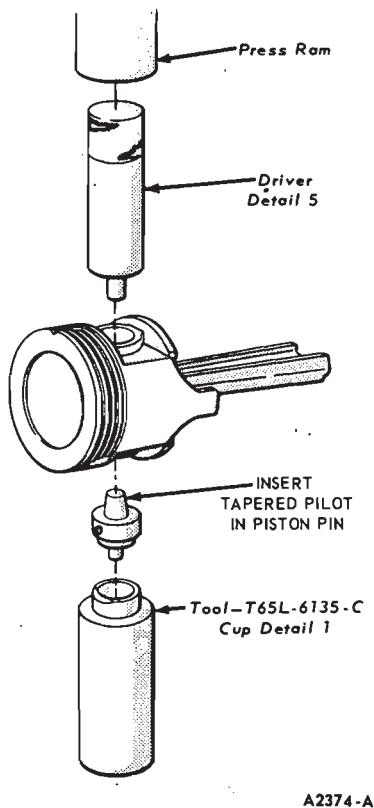


FIG. 48—Checking Connecting Rod Side Clearance



**FIG. 49—Removing or Installing Piston Pin**

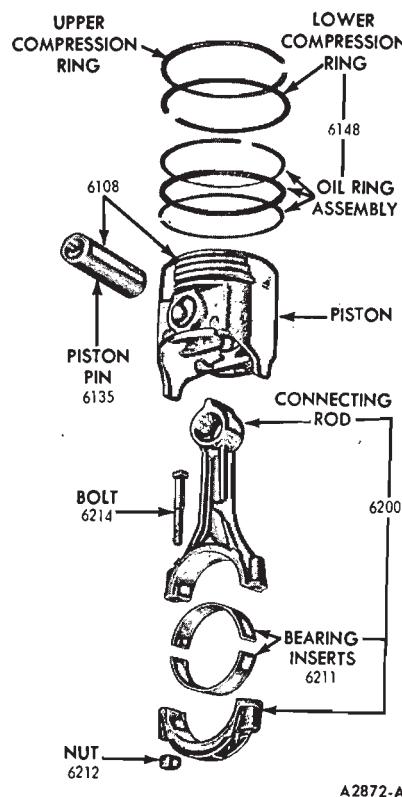
#### piston and piston pin to the connecting rod.

The piston pin bore of a connecting rod and the diameter of the piston pin must be within specifications. Refer to Section 5.

1. Apply a light coat of engine oil to all parts. Assemble the piston to the connecting rod with the cylinder number side of the connecting rod and the indentation notch or arrow in the piston positioned as shown in Figs. 51 and 52. On replacement connecting rods, install the large-chamfered side of the connecting rod bearing bore towards the crankshaft cheek; facing towards front of engine on right bank rods, and facing towards rear of engine on left bank rods.

2. Start the piston pin in the piston and connecting rod (this may require a very light tap with a mallet). Using an Arbor Press, press the piston pin through the piston and connecting rod until the pin is centered in the piston (Fig. 49).

3. Check the end gap of all piston rings (Part 21-01). It must be within specifications (Section 5). Follow the instructions contained on the piston ring package and install the piston rings.



**FIG. 50—Piston, Connecting Rod and Related Parts**

4. Check the ring side clearance of the compression rings with a feeler gauge inserted between the ring and its lower land (Part 21-01, Section 2). The gauge should slide freely around the entire ring circumference without binding. Any wear that occurs will form a step at the inner portion of the lower land. If the lower lands have high steps, the piston should be replaced.

5. Be sure the bearing inserts and the bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause a failure. Install the bearing inserts in the connecting rod and cap with the tangs fitting in the slots provided.

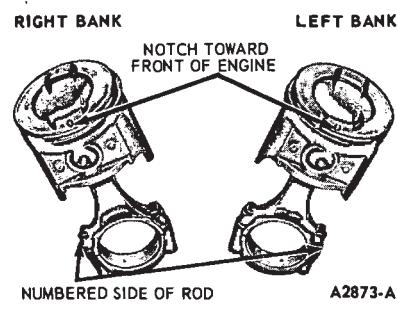
#### FLYWHEEL

#### REMOVAL

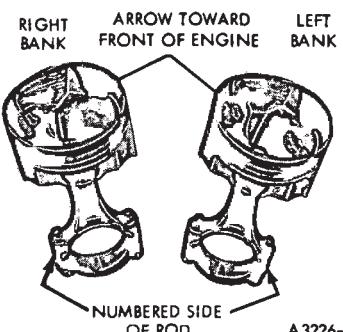
1. On a vehicle with a manual-shift transmission, remove the transmission, clutch pressure plate and disc following the procedures in Group 16.

On a vehicle with automatic transmission, remove the transmission and converter housing following the procedure in Group 17.

2. To check flywheel face runout



**FIG. 51—Correct Piston and Rod Positions—302-2V and 351-W Engines**



**FIG. 52—Correct Piston and Rod Positions—302 BOSS Engines**

or replace flywheel ring gear for manual-shift transmissions, refer to Part 21-01, Section 2.

3. Remove the flywheel attaching bolts and remove the flywheel.

#### INSTALLATION

1. Coat the threads of the flywheel attaching bolts with oil-resistant sealer. Position the flywheel on the crankshaft flange. Install and torque the bolts in sequence across from each other to specifications.

2. On a vehicle with a manual-shift transmission, check the flywheel runout, following the procedure in Part 21-01, Section 1 and install the clutch pressure plate, disc and the transmission following the procedures in Group 16.

On a vehicle with an automatic transmission, check the flywheel runout, following the procedure in Part 21-01, Section 1 and install the transmission and converter housing following the procedure in Group 17.

#### CLUTCH PILOT BUSHING

#### REMOVAL

1. Remove the transmission, clutch

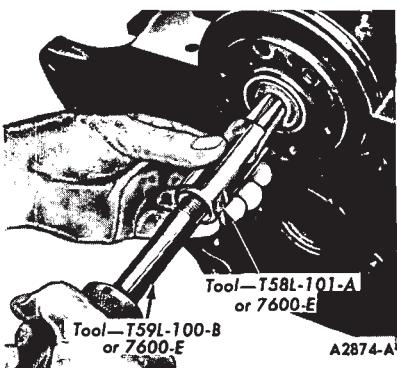


FIG. 53—Removing Clutch Pilot Bushing



FIG. 54—Installing Clutch Pilot Bearing

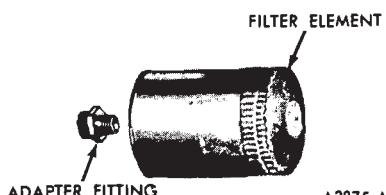


FIG. 55—Cartridge-Type Oil Filter

pressure plate and disc, following the procedures in Group 16.

2. Remove the pilot bushing as shown in Fig. 53.

#### INSTALLATION

1. Coat the pilot bushing bore in the crankshaft with a small quantity of wheel bearing lubricant. Avoid using too much lubricant as it may be thrown onto the clutch disc when the clutch revolves.

2. Install the pilot service bearing as shown in Fig. 54.

3. Install the clutch pressure plate, disc and the transmission, following

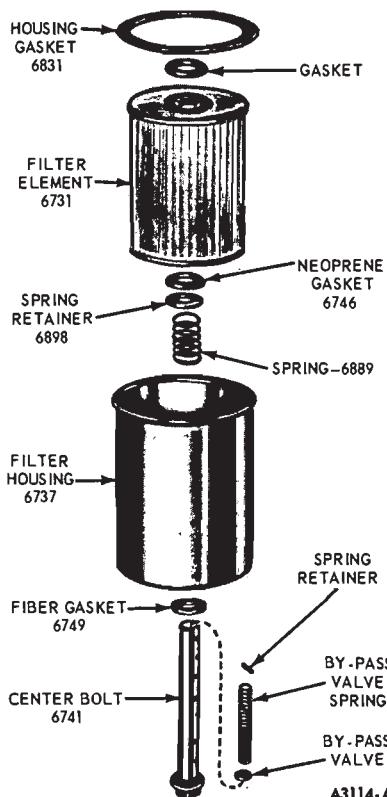


FIG. 56—Element-Type Oil Filter  
the procedures in Group 16.

#### OIL FILTER

##### CARTRIDGE-TYPE OIL FILTER

The oil filter assembly is shown in Fig. 55.

#### Removal

1. Place a drip pan under the filter. Unscrew the filter from the adapter fitting and clean the adapter recess.

#### Installation

1. Coat the gasket on a new filter with oil. Place the new filter in position on the adapter fitting. Hand tighten the filter until the gasket contacts the adapter face, and then advance it 1/2 turn.

2. Operate the engine at fast idle, and check for oil leaks. If oil leaks are evident, perform the necessary repairs to correct leakage. Check the oil level and fill the crankcase if necessary.

##### ELEMENT-TYPE OIL FILTER

The oil filter assembly is shown in Fig. 56.

#### Removal

1. Place a drip pan under the filter. Loosen the filter center bolt, and then remove the filter assembly and gasket.

2. Remove the filter element, neoprene gasket, spring and seat. Remove the center bolt from the filter cover and the fiber gasket from the bolt. Discard the filter element and all gaskets.

#### Installation

1. Wash all parts in solvent. Make sure all the openings in the center bolt are clean.

2. Install a new filter element in the filter cover following the instructions furnished with the new element.

3. Clean the oil filter cover mounting surface on the adapter. Position a new gasket in the adapter recess.

4. Place the filter assembly in position, and thread the center bolt into the adapter finger-tight. Rotate the filter slightly, in each direction, to make sure the gasket is seated evenly.

5. Torque the center bolt to specifications. Do not over-tighten the center bolt.

6. Add oil to the crankcase if necessary. Operate the engine at fast idle, and check for leaks.

7. If oil leaks are evident, perform the necessary repairs to correct the leakage.

#### OIL PAN

##### REMOVAL

###### Ford and Meteor

1. Remove the oil level dipstick.  
2. Remove the bolts attaching the fan shroud to the radiator and position the shroud over the fan.

3. Raise the vehicle.

4. Drain the crankcase.

5. Remove the bolts and nuts retaining the engine supports to the chassis.

6. Raise the engine and place wood blocks between the engine supports and chassis brackets.

7. Disconnect the stabilizer from the lower control arms and pull ends down.

8. Remove the oil pan attaching bolts and position the pan on the crossmember.

9. Position the stabilizer bar for clearance and remove the oil pan.

**Mustang and Cougar**

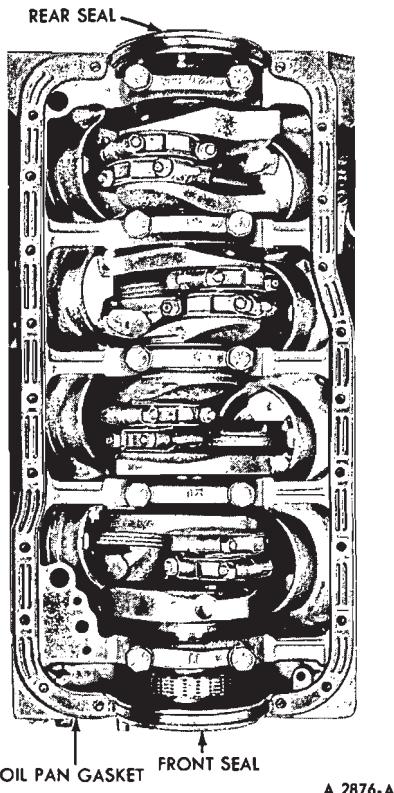
1. Remove the oil level dipstick.
2. Raise the vehicle.
3. Drain the crankcase.
4. Remove the bolts retaining the stabilizer to the frame.
5. Remove the two bolts retaining the number two crossmember to the chassis (under the engine).
6. Remove the oil pan attaching bolts.
7. Turn the crankshaft for maximum clearance and remove the oil pan.

**Fairlane, Falcon and Montego**

1. Remove the oil level dipstick. Remove the bolts attaching the fan shroud to the radiator. Position the shroud over the fan.
2. Raise the vehicle.
3. Drain the crankcase.
4. Remove the stabilizer bar from the chassis.
5. Remove the engine front support through bolts.
6. Raise the engine and place wood blocks between the engine supports and chassis brackets.
7. If equipped with an automatic transmission, disconnect the oil cooler lines at the radiator.
8. Remove the oil pan retaining bolts and lower the oil pan onto the crossmember.
9. Remove oil pump pickup tube and screen from the oil pump. Rotate the crankshaft for clearance and remove the oil pan.

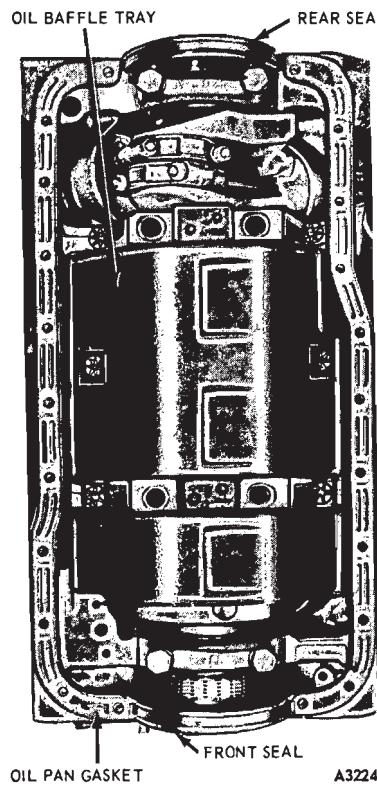
**INSTALLATION****Ford and Meteor**

1. Clean the gasket surfaces of the block and oil pan. The oil pan has a two-piece gasket. Coat the block surface and the oil pan gasket with sealer. Position the oil pan gaskets on the cylinder block (Fig. 57).
2. Position the oil pan front seal on the cylinder front cover. Be sure the tabs on the seal are over the oil pan gasket.
3. Position the oil pan rear seal on the rear main bearing cap (Fig. 57). Be sure the tabs on the seal are over the oil pan gasket.
4. Position the oil pan against the block and install a bolt, finger-tight, on each side of the oil pan. Install the remaining bolts. Tighten the bolts from the center outward in each direction to specifications.



A 2876-A

**FIG. 57—Oil Pan Gaskets and Seals Installed—302 and 351-W Engines**



A3224-B

**FIG. 58—Oil Pan Gaskets and Seals Installed—Oil Baffle Tray—302 BOSS Engines**

5. Connect the stabilizer to lower control arms.
6. Raise the engine and remove the wood blocks from between the engine support and chassis bracket. Lower the engine.
7. Install the bolts and nut attaching the engine supports to the chassis. Tighten the nuts to specifications.
8. Lower the vehicle.
9. Install the bolts attaching the shroud to the radiator.
10. Install the oil level dipstick. Fill the crankcase with the proper grade and quantity of engine oil. Start the engine and check for oil leaks.

**Mustang and Cougar**

1. Clean the gasket surfaces of the block and oil pan. The oil pan has a two-piece gasket. Coat the block surface and the oil pan gasket with sealer. Position the oil pan gaskets on the cylinder block (Figs. 57 and 58).
2. Position the oil pan front seal on the cylinder front cover. Be sure

the tabs on the seal are over the oil pan gasket.

3. Position the oil pan rear seal on the rear main bearing cap (Figs. 57 and 58). Be sure the tabs on the seal are over the oil pan gasket.

4. Position the oil pan against the block and install a bolt, finger-tight, on each side of the oil pan. Install the remaining bolts. Tighten the bolts from the center outward in each direction to specifications.

5. Install the number two crossmember and tighten the bolts to specification.

6. Install the stabilizer to the frame. Tighten the nuts to specification.

7. Lower the vehicle.

8. Install the oil level dipstick. Fill the crankcase with the proper grade and quantity of engine oil. Start the engine and check for oil leaks.

**Fairlane, Falcon, and Montego**

1. Clean the gasket surfaces of the block and oil pan. The oil pan has a two-piece gasket.
2. Clean the oil pump pick up tube

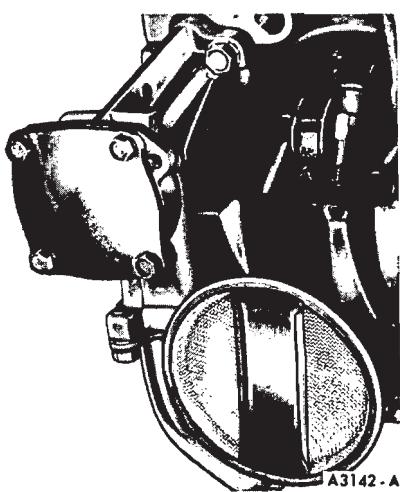


FIG. 59—Oil Pump and Inlet Tube Installed

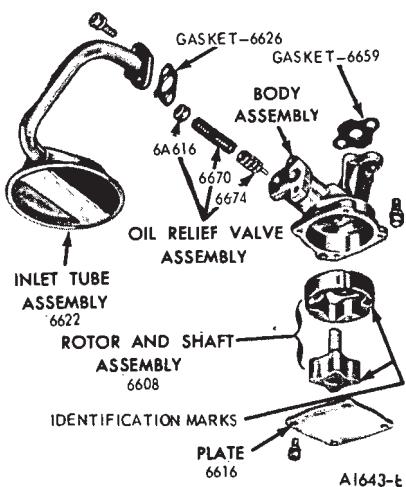


FIG. 60—Oil Pump Assembly

and screen.

3. Coat the block surface and the oil pan gasket with sealer. Position the oil pan gaskets on the cylinder block (Fig. 57).

4. Position the oil pan front seal on the cylinder front cover. Be sure the tabs on the seal are over the oil pan gasket.

5. Position the oil pan rear seal on the rear main bearing cap (Fig. 57). Be sure the tabs on the seal are over

the oil pan gasket.

6. Position the oil pan on the crossmember. Install a new gasket on the oil pump and install the oil pump pick up tube.

7. Position the oil pan against the block and install a bolt, finger tight, on each side of the block. Install the remaining bolts. Tighten the bolts from the center outward in each direction to specifications.

8. If equipped with an automatic transmission, connect the oil cooler lines at the radiator.

9. Raise the engine and remove the wood blocks from between the engine supports and chassis brackets. Lower the engine and install the engine support through bolts. Tighten the bolts to specifications.

10. Install the stabilizer bar to the chassis.

11. Lower the vehicle.

12. Install the fan shroud.

13. Install the oil level dipstick. Fill the crankcase with the proper grade and quantity of engine oil. Start the engine and check for oil leaks.

## OIL PUMP

### REMOVAL

1. Remove the oil pan and related parts as outlined under Oil Pan Removal.

2. Remove the oil pump inlet tube and screen assembly.

3. Remove the oil pump attaching bolts and remove the oil pump, gasket and intermediate drive shaft.

### INSTALLATION

1. Prime the oil pump by filling either the inlet or outlet port with engine oil. Rotate the pump shaft to distribute the oil within the pump body.

2. Position the intermediate drive shaft into the distributor socket. With the shaft firmly seated in the distributor socket, the stop on the shaft should touch the roof of the crankcase. Remove the shaft and position the stop as necessary.

3. Position a new gasket on the pump housing. With the stop properly positioned, insert the intermediate drive shaft into the oil pump. Install the pump and shaft as an assembly. Do not attempt to force the pump into position if it will not seat readily. The drive shaft hex may be misaligned with the distributor shaft. To align, rotate the intermediate drive shaft into a new position. Torque the oil pump attaching screws to specifications.

4. Clean and install the oil pump inlet tube and screen assembly (Fig. 59).

5. Install the oil pan and related parts as outlined under Oil Pan Installation.

## DISASSEMBLY

1. Remove the oil inlet tube from the oil pump and remove the gasket.

2. Remove the cover attaching screws, then remove the cover. Remove the inner rotor and shaft assembly, then remove the outer race.

3. Insert a self-threading sheet metal screw of the proper diameter into the oil pressure relief valve chamber cap and pull the cap out of the chamber. Remove the spring and plunger.

## ASSEMBLY

The oil pump assembly is shown in Fig. 60.

1. Oil all parts thoroughly.

2. Install the oil pressure relief valve plunger, spring and a new cap.

3. Install the outer race and the inner rotor and shaft assembly. Be sure the dimple (identification mark) on the outer race is facing outward and on same side as identification mark on rotor. The race, rotor and shaft and the outer race are serviced as an assembly. One part should not be replaced without replacing the other. Install the cover and torque the cover attaching screws to specifications.

4. Position a new gasket and the oil inlet tube on the oil pump and install the attaching bolts.

### 3 ENGINE REMOVAL AND INSTALLATION

The engine removal and installation procedures are for the engine only without the transmission attached.

#### REMOVAL

1. Drain the cooling system and the crankcase.

2. Remove the hood. Disconnect the battery and alternator ground cables from the cylinder block.

3. Remove the air cleaner and intake duct assembly.

4. Disconnect the radiator upper hose from the coolant outlet housing and the radiator lower hose at the water pump.

On a vehicle with an automatic transmission, disconnect the transmission oil cooler lines from the radiator.

Remove the bolts securing the fan shroud to the radiator, if so equipped.

5. Remove the radiator. Remove the fan, spacer, belt and pulley.

6. Remove the alternator bolts and position the alternator out of the way.

7. Disconnect the oil pressure sending unit wire from the sending unit, and the flexible fuel line at the fuel tank line. Plug the fuel tank line.

8. Disconnect the accelerator rod from the carburetor.

On a vehicle with an automatic transmission disconnect the throttle valve vacuum line from the intake manifold. Disconnect the manual shift rod and remove the retracting spring. Disconnect the transmission filler tube bracket from the cylinder block.

On a vehicle with an air conditioner, isolate and remove the compressor as outlined in Group 34.

On a vehicle with power steering, disconnect the power steering pump bracket from the cylinder head. Remove the drive belt. Position the power steering pump out of the way and in a position that will prevent the fluid from draining out.

On a vehicle with power brakes, disconnect the brake vacuum line from the intake manifold.

9. Remove the heater hose from the automatic choke housing. Disconnect the heater hoses from the water pump and intake manifold. Disconnect the water temperature sending unit wire from the sending unit.

10. Remove the flywheel or converter housing to engine upper bolts.

11. Disconnect the primary wire from the ignition coil. Remove the wire harness from the left rocker arm

cover and position the wires out of the way. Disconnect the ground strap from the block.

12. Raise the front of the vehicle. Disconnect the starter cable from the starter. Remove the starter and dust seal.

13. Disconnect the muffler inlet pipes from the exhaust manifolds. Disconnect the engine support insulators from the brackets on the frame underbody.

On a vehicle with a manual-shift transmission. Remove the bolts retaining the clutch equalizer bar to the frame rail and remove the equalizer from the engine block. Remove the remaining flywheel housing to engine bolts.

On a vehicle with an automatic transmission, disconnect transmission cooler lines from retainer and remove the converter housing inspection cover. Disconnect the flywheel from the converter. Secure the converter assembly in the housing. Remove the bolts retaining the transmission linkage cross shaft to the frame rail and remove the shaft from the engine block if so equipped. Remove the remaining converter housing to engine bolts.

14. Lower the vehicle, and then support the transmission. Attach the engine lifting sling, Tool No. T53L-300-A, and hoist to lifting brackets at exhaust manifolds.

15. Raise the engine slightly and carefully pull it from the transmission. Carefully lift the engine out of the engine compartment so that the rear cover plate is not bent or components damaged. Install the engine on a work stand.

#### INSTALLATION

1. Attach the engine lifting sling, Tool No. T53L-300-A, and hoist to lifting brackets at the exhaust manifold. Remove the engine from the work stand.

2. Lower the engine carefully into the engine compartment. Make sure the exhaust manifolds are properly aligned with the muffler inlet pipes.

On a vehicle with an automatic transmission, start the converter pilot into the crankshaft.

On a vehicle with a manual-shift transmission, start the transmission main drive gear into the clutch disc. It may be necessary to adjust the po-

sition of the transmission in relation to the engine if the input shaft will not enter the clutch disc. If the engine hangs up after the shaft enters, turn the crankshaft slowly (transmission in gear) until the shaft splines mesh with the clutch disc splines.

3. Install the flywheel or converter housing upper bolts, making sure that the dowels in the cylinder block engage the flywheel housing.

4. Install the engine support insulator to bracket attaching nuts. Disconnect the engine lifting sling and remove the lifting brackets.

5. Raise the front of the vehicle. Connect both muffler inlet pipes to the exhaust manifolds. Torque the nuts to specifications.

6. Position the dust seal and install the starter and the starter cable.

On a vehicle with a manual-shift transmission, install the remaining flywheel housing to engine bolts. Position the clutch equalizer bar to the engine block and install the equalizer bar bracket on the frame side rail.

On a vehicle with an automatic transmission, remove the retainer securing the converter in the housing.

Attach the converter to the flywheel. Install the converter housing inspection cover. Install the remaining converter housing attaching bolts.

Position the transmission linkage cross shaft, if so equipped, to the engine block and install the bracket on the frame side rail.

7. Remove the support from the transmission and lower the vehicle.

8. Connect the wiring harness to the left valve rocker arm cover and connect the coil wire.

9. Connect the water temperature sending unit wire. Install the heater hose on the automatic choke housing and connect the hose to the intake manifold.

10. Connect the bellcrank to the intake manifold.

On a vehicle with an automatic transmission, connect the transmission filler tube bracket. Connect the manual shift rod and install the retracting spring. Connect the throttle valve vacuum line.

Connect the accelerator rod.

11. Remove the plug from the fuel tank line and connect the fuel line and the oil pressure sending unit wire.

12. Install the pulley, belt, spacer and fan.

13. Position the alternator and in-

stall the alternator bolts. Connect the alternator and the battery ground cables. Adjust the belt tension to specifications.

On a vehicle with an air conditioner, install the compressor as outlined in Group 34.

On a vehicle with power steering, install the drive belt and power steering pump bracket. Install the bracket attaching bolts. Adjust the drive belt

tension to specifications.

On a vehicle with power brakes, connect the brake vacuum line.

14. Place the radiator shroud over the fan, if so equipped. Install the radiator. Connect the radiator upper and lower hoses. On a vehicle with an automatic transmission, connect the transmission fluid cooler lines. Install the shroud bolts if so equipped.

15. Connect the heater hose at the

water pump. Fill and bleed the cooling system. Fill the crankcase with the proper grade and quantity of oil.

16. Adjust the transmission throttle linkage.

17. Operate the engine at fast idle and check all gaskets and hose connections for leaks.

18. Install the air cleaner and intake duct assembly.

19. Install and adjust the hood.

## 4 MAJOR REPAIR OPERATIONS

When installing nuts or bolts that must be torqued (refer to Section 5 for torque specifications), oil the threads with light weight engine oil. **Do not oil threads that require oil-resistant or water-resistant sealer.**

To perform the operations in this section, it will be necessary to remove the engine from the vehicle and install it on a work stand.

Refer to Part 21-01, Section 3 for cleaning and inspection procedures.

### CRANKSHAFT

The crankshaft and related parts are shown in Fig. 61.

#### REMOVAL

1. Disconnect the spark plug wires at the spark plugs and remove the wires from the ignition harness brackets on the valve rocker arm covers. Disconnect the coil to distributor high tension lead at the coil. Remove the distributor cap and spark plug wire assembly. Remove the spark plugs to allow easy rotation of the crankshaft.

2. Remove the fuel pump and oil filter. Slide the water pump bypass hose clamp toward the water pump. Remove the alternator and mounting brackets.

3. Remove the crankshaft pulley from the crankshaft vibration damper. Remove the cap screw and washer from the end of the crankshaft. Install the puller on the crankshaft vibration damper (Fig. 33) and remove the damper.

4. Remove the cylinder front cover and water pump as an assembly.

5. Remove the crankshaft front oil slinger. Check the timing chain deflection, then remove the timing chain and sprockets as detailed under Cylinder Front Cover and Timing Chain

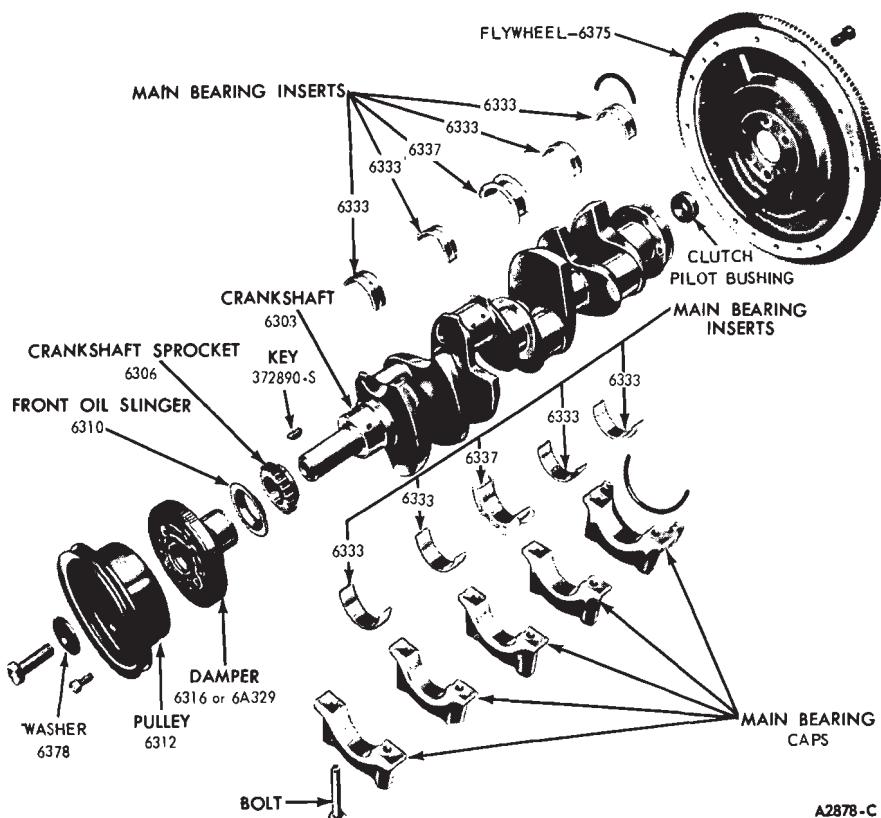


FIG. 61—Crankshaft and Related Parts

#### Removal.

6. Invert the engine on the work stand. Remove the clutch pressure plate and disc (manual-shift transmission). Remove the flywheel and engine rear cover plate. Remove the oil pan and gasket. Remove the oil pump.

On 302 BOSS engines, remove the oil baffle tray from the main bearing cap bolts.

7. Make sure all bearing caps (main and connecting rod) are marked so that they can be installed

in their original locations. Turn the crankshaft until the connecting rod from which the cap is being removed is down, and remove the bearing cap. Push the connecting rod and piston assembly up into the cylinder. Repeat this procedure until all the connecting rod bearing caps are removed.

8. Remove the main bearing caps.

9. Carefully lift the crankshaft out of the block so that the thrust bearing surfaces are not damaged. Handle the crankshaft with care to avoid possible fracture or damage to the finished

surfaces.

To refinish journals, dress minor imperfections, etc., refer to Part 21-01, Section 2.

## INSTALLATION

1. Remove the rear journal oil seal from the block and rear main bearing cap.

2. Remove the main bearing inserts from the block and bearing caps.

3. Remove the connecting rod bearing inserts from the connecting rods and caps.

4. If the crankshaft main bearing journals have been refinished to a definite undersize, install the correct undersize bearings. Be sure the bearing inserts and bearing bores are clean. Foreign material under the inserts will distort the bearing and cause a failure.

5. Place the upper main bearing inserts in position in the bores with the tang fitting in the slot provided.

6. Install the lower main bearing inserts in the bearing caps.

7. Clean the rear journal oil seal groove and the mating surfaces of the block and rear main bearing cap. Remove the oil seal retainer pin from the rear main bearing seal groove, if so equipped. **The retainer pin is not used with a split lip seal.**

8. Dip the lip seal halves in clean engine oil. Carefully install the seal halves in the block and rear main bearing cap with the undercut sides of the seal toward the FRONT of the engine (Fig. 44) and approximately 3/8 inch protruding above the partial surface.

9. Carefully lower the crankshaft into place. **Be careful not to damage the bearing surfaces.**

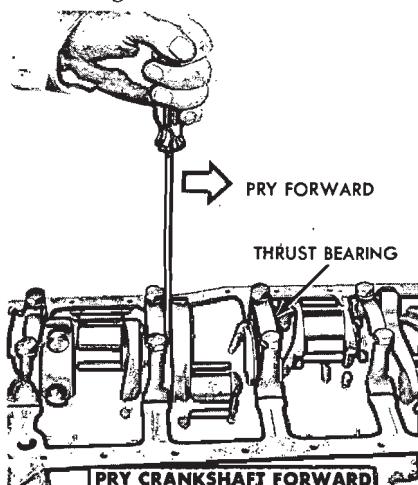


FIG. 62—Aligning Thrust Bearing

10. Check the clearance of each main bearing following the procedure under Fitting Main and Connecting Rod Bearings in Part 21-01.

11. After the bearings have been fitted, apply a light coat of engine oil to the journals and bearings. Install a new seal in the rear main bearing cap and install the rear main bearing cap by following steps 7 thru 9 under Main Bearing Installation. Install all the bearing caps, except the thrust bearing cap (No. 3 bearing). Be sure that the main bearing caps are installed in their original locations. Torque the bearing cap bolts to specifications.

12. Install the thrust bearing cap with the bolts finger-tight.

13. Pry the crankshaft forward against the thrust surface of the upper half of the bearing (Fig. 62).

14. Hold the crankshaft forward and pry the thrust bearing cap to the rear. This will align the thrust surfaces of both halves of the bearing.

15. Retain the forward pressure on the crankshaft. Tighten the cap bolts to specifications.

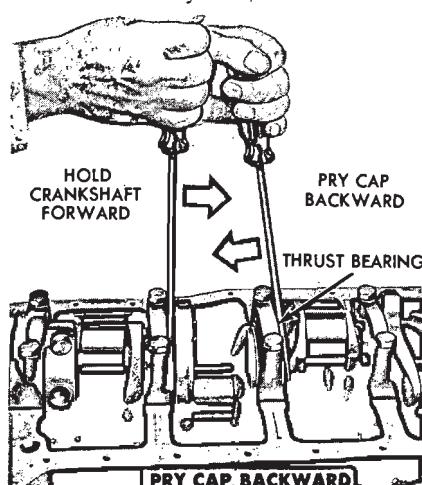
16. Force the crankshaft toward the rear of the engine.

17. Check the crankshaft end play (refer to Part 21-01, Section 1).

18. Install new bearing inserts in the connecting rods and caps. Check the clearance of each bearing following the procedure under Fitting Main and Connecting Rod Bearings in Part 21-01.

19. After the connecting rod bearings have been fitted, apply a light coat of engine oil to the journals and bearings.

20. Turn the crankshaft throw to the bottom of its stroke. Push the piston all the way down until the rod



bearing seats on the crankshaft journal.

21. Install the connecting rod cap. Torque the nuts to specifications.

22. After the piston and connecting rod assemblies have been installed, check the side clearance between the connecting rods on each connecting rod crankshaft journal (Fig. 48).

23. On 302 BOSS engines, install the oil baffle tray on the main bearing cap bolts.

24. Install the timing chain and sprockets, cylinder front cover and crankshaft pulley and adapter, following steps 1 thru 9 under Cylinder Front Cover and Timing Chain Installation.

25. Coat the threads of the flywheel attaching bolts with oil-resistant sealer. Position the flywheel on the crankshaft flange. Install and torque the bolts to specifications.

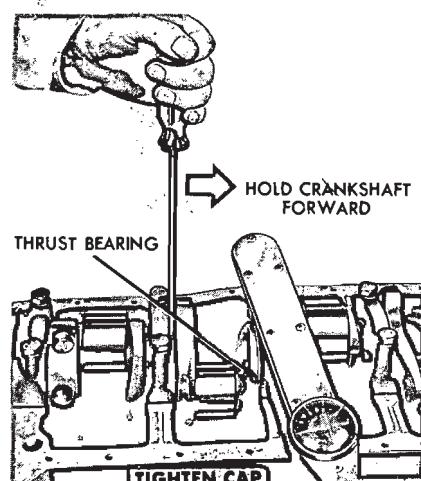
On a flywheel for a manual-shift transmission, use tool 6392-N to locate the clutch disc. Install the pressure plate. Tighten the attaching bolts.

26. Clean the oil pan, oil pump and oil pump screen. Prime the oil pump by filling either the inlet or outlet port with engine oil and rotating the pump shaft to distribute oil within the housing. Install the oil pump and oil pan by following the procedures under Oil Pan and Oil Pump Installations.

27. Install the oil filter, fuel pump and connect the fuel lines. Install the alternator, shield and mounting bracket.

28. Install the spark plugs, distributor cap and spark plug wires. Connect the spark plug wires and high tension lead.

29. Install the engine in the vehicle.



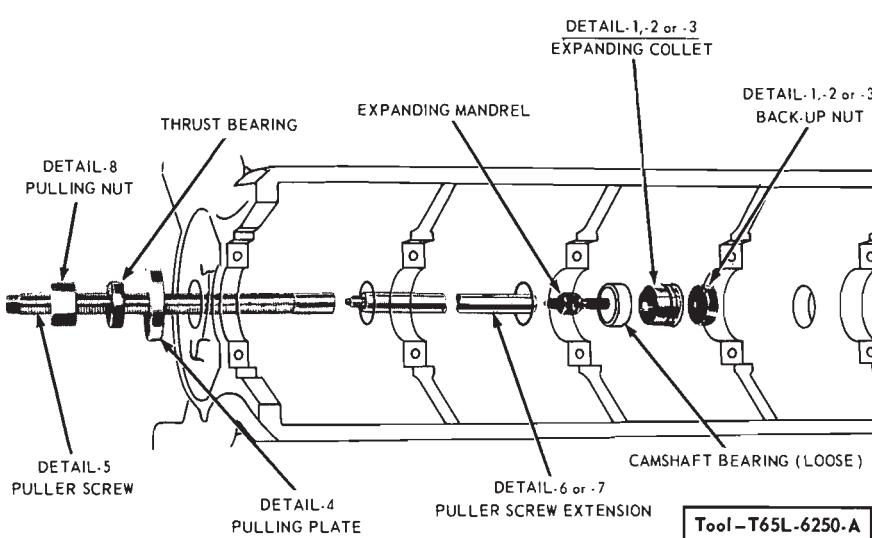


FIG. 63—Camshaft Bearing Replacement

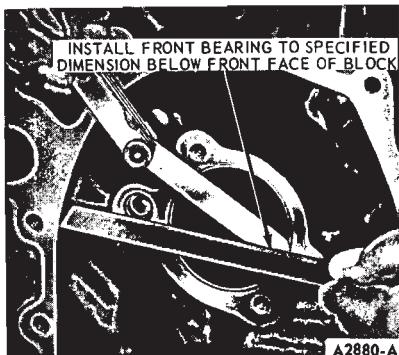


FIG. 64—Camshaft Front Bearing Measurement

**CAMSHAFT BEARING****REMOVAL**

1. Remove the camshaft, flywheel and crankshaft, following the appropriate procedures in Section 2 or Section 4. Push the pistons to the top of the cylinders.

2. Remove the camshaft rear bearing bore plug. Remove the camshaft bearings (Fig. 63).

3. Select the proper size expanding collet and back-up nut and assemble on the expanding mandrel. With the expanding collet collapsed, install the collet assembly in the camshaft bearing, and tighten the back-up nut on the expanding mandrel until the collet fits the camshaft bearing.

4. Assemble the puller screw and extension (if necessary) as shown and

install on the expanding mandrel. Wrap a cloth around the threads of the puller screw to protect the front bearing or journal. Tighten the pulling nut against the thrust bearing and pulling plate to remove the camshaft bearing. Be sure to hold a wrench on the end of the puller screw to prevent it from turning.

5. Repeat the procedure for each bearing. To remove the front bearing, install the puller screw from the rear of the cylinder block.

**INSTALLATION**

Camshaft bearings are available pre-finished to size for standard and 0.015-inch undersize journal diameters. The bearings are not interchangeable from one bore to another.

1. Position the new bearings at the bearing bores with the oil holes aligned, and press them in place with the tool shown in Fig. 63. Be sure to center the pulling plate and puller screw to avoid damage to the bearing. Failure to use the correct expanding collet can cause severe bearing damage. Be sure the front bearing is installed the specified distance below the front face of the cylinder block (Fig. 64).

2. Install the core plug as detailed in Part 21-01, Section 2.

3. Install the camshaft, crankshaft, flywheel and related parts, following the appropriate procedures in Section 2 or Section 4, except do not check

connecting rod and main bearing clearances as a part of Camshaft Bearing Replacement. Install the engine in the vehicle.

**CYLINDER ASSEMBLY REPLACEMENT****DISASSEMBLY**

Follow steps 1 thru 14 and 17 thru 19 under Engine Disassembly. Remove 4 cylinder head dowels from the cylinder block. Remove the cylinder block drain plugs, and remove the cylinder assembly from the work stand.

**ASSEMBLY**

Clean the gasket and seal surfaces of all parts and assemblies.

Install the replacement cylinder assembly on a work stand. Install the cylinder block drain plugs and cylinder head dowels. Transfer all parts removed from the old cylinder assembly, following the procedures in steps 20 thru 25 and 30 thru 60 under Engine Assembly. Check all assembly clearances and correct as necessary.

**CYLINDER BLOCK REPLACEMENT**

Before replacing a cylinder block, determine if it is repairable, and make the necessary repairs following the procedures in Part 21-01, Section 2.

**DISASSEMBLY**

Follow steps 1 thru 25, 28 and 29 under Engine Disassembly. Remove the 4 cylinder head dowels and the cylinder block drain plugs from the cylinder block. Remove the cylinder block from the work stand.

**ASSEMBLY**

Install the replacement cylinder block on the work stand. Install the cylinder block drain plugs and cylinder head dowels. Transfer the parts removed from the old cylinder block to the new cylinder block by following steps 5 and 7 thru 60 under Engine Assembly.

Check all assembly clearances and correct as necessary.

**ENGINE DISASSEMBLY**

1. Install the engine on the work stand.

**2.** Remove the distributor cap, coil high tension wire and spark plug wires as an assembly.

**3.** Disconnect the distributor vacuum hose from the distributor. Remove the carburetor fuel inlet line and fuel pump and outlet line. Remove the fuel pump and discard the gasket. Remove the oil filter and adapter.

**4.** Slide the clamp on the water pump bypass hose toward the water pump. Remove the automatic choke heat tube.

**5.** Remove the valve rocker arm covers and the crankcase ventilating system.

**6.** On 302 BOSS engines, loosen the hose clamps and remove the Thermactor air hoses and air by-pass valve. Remove the Thermactor air pump.

**7.** Remove the alternator mounting brackets. Remove the ignition coil. Remove the distributor hold-down bolt and remove the distributor.

**8.** Remove the intake manifold attaching bolts. Raise the manifold and carefully remove it from the engine. Discard the intake manifold gaskets, seals and sealing washers.

**9.** Loosen the valve rocker arm stud nuts so that the valve rocker arms can be rotated to the side. Remove the valve push rods in sequence and put them in a rack or holder so that they can be installed in their original position.

**10.** Using a magnet, remove the valve lifters and place them in a rack so that they can be installed in their original bores (Fig. 41).

If the valve lifters are stuck in their bores by excessive varnish, etc., it may be necessary to use a plier-type tool (T52T-6500-DJD or 6500-D) or a claw-type tool to remove the lifters. Rotate the lifter back and forth to loosen it from the gum or varnish that may have formed at the lifter.

The internal parts of each hydraulic valve lifter assembly are matched sets. Do not intermix the parts. Keep the assemblies intact until they are to be cleaned.

**11.** Remove the exhaust manifolds and the spark plugs.

**12.** Install the cylinder head holding fixtures (Fig. 25). Remove the cylinder head bolts and lift the cylinder heads off the block. Discard the cylinder head gaskets.

**13.** Remove the crankshaft pulley from the crankshaft vibration damper. Remove the cap screw and washer from the end of the crankshaft. Install the puller on the crankshaft vi-

bration damper (Fig. 33) and remove the vibration damper.

**14.** Remove the oil pan to cylinder front cover attaching bolts. Remove the cylinder front cover attaching screws. Remove the cylinder front cover and water pump as an assembly. Discard the gasket and remove the crankshaft front oil slinger.

**15.** Check the timing chain deflection. Remove the camshaft sprocket cap screw, washers and fuel pump eccentric. Slide both sprockets and the timing chain forward and remove them as an assembly. Remove the crankshaft sprocket key.

**16.** Remove any ridge and/or carbon deposits from the upper end of the cylinder bores. Move the piston to the bottom of its travel and place a cloth on the piston head to collect the cuttings. Remove the cylinder ridge with a ridge cutter. Follow the instructions furnished by the tool manufacturer. Never cut into the ring travel area in excess of 1/32 inch when removing ridges. After the ridge has been removed, remove the cutter from the cylinder bore.

**17.** On a flywheel for a manual-shift transmission, remove the clutch pressure plate and disc.

**18.** Remove the flywheel and rear cover plate. Remove the clutch pilot bushing (Fig. 53).

**19.** Invert the engine. Remove the oil pan and discard the gaskets and seals.

**20.** Remove the oil pump and inlet tube as an assembly. Remove the intermediate drive shaft. Discard the oil pump gasket.

On 302 BOSS engines, remove the oil baffle tray from the main bearing cap bolts.

**21.** Make sure all connecting rods and caps are marked so that they can be installed in their original locations. Turn the crankshaft until the connecting rod being removed is down. Remove the rod cap.

**22.** Push the connecting rod and piston assembly out of the top of the cylinder with the handle end of a hammer. Avoid damage to the connecting rod journal or the cylinder wall when removing the piston and rod.

**23.** Remove the bearing inserts from the connecting rods and caps. Install the rod caps on the connecting rods from which they were removed.

**24.** Remove the main bearing caps.

**25.** Carefully lift the crankshaft out of the cylinder block so that the thrust bearing surfaces are not damaged. Handle the crankshaft with care

to avoid possible fracture or damage to the finished surfaces.

**26.** Remove the rear journal oil seal from the block and rear bearing cap.

**27.** Remove the main bearing inserts from the block and bearing caps. Install the main bearing caps in their original positions.

**28.** Remove the camshaft thrust plate. Carefully remove the camshaft by pulling it toward the front of the engine. Use caution to avoid damaging the journals and lobes.

**29.** Remove the oil filter adapter.

**30.** Remove the camshaft rear bearing bore plug. Remove the camshaft bearings (Fig. 63).

## ENGINE ASSEMBLY

If the cylinder block is to be replaced, transfer the cylinder head dowels and cylinder block drain plugs to the new cylinder block and start the assembly procedures with step number 5.

**1.** If the original cylinder block is used, remove the glaze from the cylinder bores by following the instructions in Part 21-01, Section 2.

**2.** Invert the engine on the work stand.

**3.** Position the new camshaft bearings at the bearing bores with the oil holes aligned, and press them in place with the tool shown in Fig. 63. Be sure the camshaft front bearing is installed the specified distance below the front face of the cylinder block.

**4.** Install the core plug as detailed in Part 21-01, Section 2.

**5.** Oil the camshaft journals with heavy engine oil MS and apply Lubriplate or equivalent to all lobes, and then carefully slide it through the bearings. Install the camshaft thrust plate with groove towards engine block, and then check camshaft end play as shown in Part 21-01, Section 1.

**6.** Clean the rear journal oil seal groove and the mating surfaces of the block and rear main bearing cap. Remove the seal retaining pin from the seal groove in the bearing cap, if so equipped. The pin is not used with the split lip seal.

**7.** Dip the lip seals in clean engine oil. Carefully install the seal halves in the block and rear main bearing cap with the undercut side of the seal toward the FRONT of the engine (Fig. 44) and approximately 3/8 inch protruding above the partial surface to step 9.

**8.** If the crankshaft main bearing

journals have been refinished to a definite undersize, install the correct undersize bearings. Be sure the bearing inserts and bearing bores are clean. Foreign material under the inserts will distort the bearing and cause a failure.

Place the upper main bearing inserts in position in the bore with the tang fitting in the slot provided.

**9.** Install the lower main bearing inserts in the bearing caps.

**10.** Carefully lower the crankshaft into place. **Be careful not to damage the bearing surfaces.**

**11.** Check the clearance of each main bearing following procedures under Fitting Main and Connecting Rod Bearings in Part 21-01.

**12.** After the bearings have been fitted, apply a light coat of engine oil to the journals and bearings.

**13.** Apply a thin coating of oil-resistant sealer to the rear main bearing cap at the rear of the top mating surface (Fig. 45). **Do not apply sealer to the area forward of the oil slinger groove.** Install the rear main bearing cap and the remainder of the caps, except the thrust bearing cap (No. 3 bearing). **Be sure that the main bearing caps are installed in their original positions.** Tighten the bearing cap bolts to specifications.

**14.** Install the thrust bearing cap and check crankshaft end play by following steps 12 thru 17 under Crankshaft Installation.

**15.** Turn the engine on the work stand so that the front end is up.

**16.** Install the pistons and connecting rods by following steps 1 thru 10 under Piston and Connecting Rod Installation.

**17.** Position the sprockets and timing chain on the camshaft and crankshaft (Fig. 35). Be sure the timing marks on the sprockets are positioned as shown in Fig. 34.

**18.** Lubricate the timing chain and sprockets with engine oil.

**19.** Install the fuel pump eccentric, washer and camshaft sprocket cap screw. Torque the sprocket cap screw to specifications. Install the crankshaft front oil slinger (Fig. 36).

**20.** Clean the cylinder front cover and the cylinder block gasket surfaces. Install a new crankshaft front oil seal (Fig. 39).

**21.** Coat the gasket surface of the block and cover and the cover bolt threads with oil-resistant sealer. Position a new gasket on the block.

**22.** Install the alignment pilot tool on the cylinder front cover so that the keyway in the pilot aligns with the

key in the crankshaft. Position the cover (and water pump and pilot over the end of the crankshaft and against the block) (Fig. 37).

**23.** Install the cylinder front cover screws finger-tight. While pushing in on the pilot, tighten the cover bolts to specifications. Remove the pilot.

**24.** Lubricate the crankshaft with a white lead and oil mixture and apply Lubriplate to the oil seal rubbing surface of the vibration damper inner hub to prevent damage to the oil seal.

**25.** Line up the crankshaft vibration damper keyway with the key on the crankshaft, and then install the vibration damper on the crankshaft (Fig. 38). Install the damper cap screw and washer, and torque the screw to specifications. Install the crankshaft pulley.

**26.** Invert the engine on the work stand. Position the intermediate drive shaft into the distributor socket. With the shaft firmly seated in the distributor socket, the stop on the shaft should touch the roof of the crankcase. Remove the shaft and position the stop as necessary.

**27.** With the stop properly positioned, insert the intermediate drive shaft into the oil pump.

**28.** Prime the oil pump by filling either the inlet or outlet port with engine oil. Rotate the pump shaft to distribute the oil within the pump body.

**29.** Position a new gasket on the pump housing and install the pump and shaft as an assembly. **Do not attempt to force the pump into position if it will not seat readily. The drive shaft hex may be misaligned with the distributor shaft. To align, rotate the intermediate shaft into a new position. Tighten the oil pump attaching screws to specifications.**

**30.** Clean the gasket surfaces of the block and oil pan. Coat the block surface and the oil pan gasket surface with sealer. Position new gaskets on the block and position a new seal on the cylinder front cover and rear main bearing cap. Make sure the tabs on the seal are over the oil pan gasket. Install the attaching screws and tighten them from the center outward to specifications (one screw secures the fuel line bracket).

**31.** Using a new gasket install the fuel pump.

**32.** Turn the engine on the work stand so that the top of the engine is up.

**33.** Clean the cylinder head and block gasket surfaces. Install the head gasket over the cylinder head dowels.

**Do not apply sealer to the head gasket surfaces.**

**34.** Place the cylinder head on the engine, then remove the holding fixtures. Coat the head bolt threads with water-resistant sealer, and then install the bolts.

**35.** The cylinder head bolt tightening procedure is performed in three progressive steps. Tighten the bolts in sequence (Fig. 26) to 50 ft-lbs, then to 60 ft-lbs and finally to specifications. When cylinder head bolts have been tightened following this procedure, it is not necessary to retorque the bolts after extended operation. However, the bolts may be checked and retorqued, if desired.

**36.** Coat the cylinder head mating surfaces of the exhaust manifold with a light film of graphite grease. Position new gaskets on the muffler inlet pipe.

**37.** Position the exhaust manifolds on the cylinder heads and install the attaching bolts and flat washers. Tighten the attaching bolts to specifications, working from the center to the ends.

**38.** Install the spark plugs.

**39.** Use the hydraulic valve lifter leakdown tester (Part 21-01) to fill the lifters with test fluid. Lubricate the lifters and bores with heavy engine oil MS to provide initial lubrication. Place each lifter in the bore from which it was removed.

**40.** Install the push rods in their original positions. Apply Lubriplate or equivalent over the valve stem tips. Lubricate the rocker arms and fulcrum seats with heavy engine oil MS and install the rocker arms over the push rods.

On 302-2V and 351-W engines, perform a valve clearance adjustment as outlined under Valve Clearance Adjustment—Hydraulic Valve Lifters

On 302 BOSS engines, perform a preliminary valve lash adjustment following procedures under Valve Clearance Adjustment—Mechanical Tap-pet.

**41.** Clean the mating surfaces of the intake manifold, cylinder heads and cylinder block.

**42.** Coat the intake manifold and cylinder block seal surfaces with quick setting adhesive.

**43.** Position new seals on the cylinder block and new gaskets on the cylinder heads with the gaskets interlocked with the seal tabs. Apply non-hardening sealer at the four junction points of the seals and gaskets. Be sure the holes in the gaskets are aligned with the holes in the cylinder

heads.

44. Carefully lower the intake manifold on the cylinder block and cylinder heads. After the intake manifold is in place, run a finger around the seal area to make sure the seals are in place. If the seals are not in place, remove the intake manifold and position the seals.

45. Be sure the holes in the manifold gaskets and manifold are in alignment. Using new sealing washers, install the intake manifold attaching bolts and nuts. Tighten the intake manifold bolts and nuts in two steps (Figs. 19, 20 and 21).

Tighten in sequence to specifications.

After completing the remaining assembly steps, operate the engine until it reaches normal operating temperature, then retorque the manifold bolts in sequence to specifications.

46. Install the water pump bypass hose on the coolant outlet housing. Slide the clamp into position and tighten the clamp.

47. Rotate the crankshaft until the No. 1 piston is on TDC, then position the distributor in the block with the rotor at the No. 1 firing position and the points open. Install the hold down clamp.

48. Install the ignition coil. Position and install the alternator mount-

ing bracket.

49. Clean the valve rocker arm covers and the cylinder head gasket surface. Apply oil-resistant sealer to one side of new cover gaskets. Lay the cemented side of the gaskets in place in the covers.

50. Position the covers on the cylinder heads. Make sure the gasket seats evenly all around the head. Install the bolts. The cover is tightened in two steps. Torque the bolts to specifications. Two minutes later, torque the bolts to the same specifications.

51. Install the crankcase ventilation system.

52. Install the automatic choke heat tube. Install the distributor cap. Position the spark plug wires in the brackets on the valve rocker arm covers. Connect the spark plug wires and the coil wire.

53. Connect the carburetor fuel inlet line and fuel pump outlet line.

54. On 302 BOSS engines, install the Thermactor air pump. Install the air hose and air by-pass valve assembly.

55. Install the oil filter adapter. Clean the oil filter gasket surface. Coat the gasket on the filter with oil. Place the filter in position on the adapter fitting. Hand tighten the filter

until the gasket contacts the adapter face, then advance it 1/2 turn.

56. Install the clutch pilot service bearing (Fig. 54). Coat the threads of the flywheel attaching bolts with oil-resistant sealer. Position the rear cover plate on the block and the flywheel on the crankshaft flange. Install and torque the bolts to specifications.

On a flywheel for a manual-shift transmission, use tool T58P-7563-A to locate the clutch disc. Install the pressure plate.

57. Install the engine in the vehicle. Fill and bleed the cooling system. Fill the crankcase with the proper grade and quantity of engine oil.

58. Operate the engine and check for oil and coolant leaks. Check and adjust the ignition timing. Connect the distributor vacuum hose to the distributor. Retorque intake manifold bolts to specifications.

59. Adjust the engine idle speed, fuel mixture and anti-stall dashpot (if applicable). Adjust the transmission throttle linkage.

60. On 302 BOSS engines, remove the valve rocker arm covers and perform a hot valve lash adjustment following procedures under Valve Clearance Adjustment—Mechanical Tap-pet.

Install the valve rocker arm covers.

## 5 SPECIFICATIONS

### GENERAL SPECIFICATIONS

Engine	Compression Ratio	Bore and Stroke	Taxable Horsepower	Brake Horsepower	Gross Torque Ft.-Lbs.
302-2V	9.5:1	4.00 x 3.00	51.2	210 @ 4400	295 @ 2400
302 Boss	10.5:1	4.00 x 3.00	51.2	290 @ 5800	290 @ 4300
351W	9.5:1	4.00 x 3.50	51.2	250 @ 4600	355 @ 2600

### GENERAL SPECIFICATIONS (Continued)

Engine	Compression Pressure PSI (Sea Level) @ Cranking Speed ①	Engine Idle Manifold Vacuum ②	Oil Pressure-Hot @ 2000 RPM	Firing Order	Belt Tension (Ft. Lbs.) ③
302-2V	When checking compression, take the highest compression reading and compare it to the lowest reading. The lowest reading must be within 75% of the highest	16	35-60	1542 6378 1372 6548	New 140 Used 110
302 Boss		12			
351-W		18			

① See Compression Pressure Limit Chart—Part 21-01  
 ② Minimum inches of Mercury @ specified engine RPM (sea level). This includes automatic transmission in neutral. Subtract 1 inch of Mercury for engines equipped with dual diaphragm distributors.  
 ③ All belts.

### PERFORMANCE SPECIFICATIONS

Engine	Curb Idle RPM ④⑤		Fast Idle RPM	⑥ Initial Ignition Timing BTDC	Dwell Angle at Idle Speed	Distributor Point Gap	Spark Plug Gap	Spark Plug No.
	④ With Solenoid Throttle Positioner	Without Solenoid Throttle Positioner						
302-2V	800/500 Manual Transmission 600/500 Automatic Transmission	575 Automatic Transmission	1400 Man. Tran.	6°	⑦	⑧	0.035	BF-42
			1500 Auto. Tran.					
302 Boss	800/500		2150	16°	30°-33°	0.020 Dual Points	0.035	AF-32
351W-2V	700/500 Manual Transmission 600/500 Automatic Transmission	575 Automatic Transmission	1300 Man. Tran. 1600 Auto. Tran.	10°	⑨	⑩	0.035	BF-42

④ Higher idle speed with solenoid energized and lower idle speed with solenoid de-energized  
 ⑤ With head lights on high beam  
 ⑥ A/C Off, if so equipped  
 ⑦ Distributor vacuum lines disconnected  
 ⑧ Dual diaphragm distributor with single points ... 24°-29° dwell angle, 0.021 point gap  
 ⑨ Single diaphragm distributor with single points ... 26°-31° dwell angle, 0.017 point gap

### ENGINE PERFORMANCE SPECIFICATIONS (Continued)

Engine	Anti Stall Dashpot Clearance	Automatic Choke Setting	Accelerator Pump Setting			Idle Air Fuel Ratio	
			Pump Link	Lever Position			
				Man Trans	Auto Trans	Man Trans	Auto Trans
302-2V	1/8 Inch ( $\pm 1/64$ ) ⑪	1-Rich	Inboard	#3	#2	12.05:1	12.50:1
302 Boss	Solenoid Equipped	Manual Choke		Pump Cam Position #2		13.50:1	
351-W	1/8 Inch ( $\pm 1/64$ ) ⑪	2-Lean	Inboard	#3	#4	12.05:1	12.80:1

⑪ Solenoid equipped on models with manual transmission and or A/C

## CYLINDER HEAD

Engine	Combustion Chamber Volume	Valve Guide Bore Diameter (Standard Intake and Exhaust)	Valve Seat Width		Valve Seat Angle	Valve Seat Runout (Maximum)	Valve Arrangement (Front to Rear)	Rocker Arm Stud Bore Dia. Std.	Gasket Surface Flatness ①
			Intake	Exhaust					
302-2V	56.7-59.7	0.3433 0.3443	0.060 0.080	0.070 0.090	45°	0.015	Right I-E-I-E-I-E-I-E	0.3680- 0.3695	0.003 inch In Any 6 inches 0.007 Overall
302-Boss	6.13-64.3						Left E-I-E-I-E-I-E-I	7/16 x 14 Threaded Stud	
351-W	58.9-61.9								

① Head Gasket Surface Finish R.M.S. .... 90-150.

## VALVE ROCKER ARMS, PUSH RODS AND TAPPETS

Engine	Rocker Arm Lift Ratio	Valve Push Rod (Maximum Runout)	VALVE TAPPET OR LIFTER		
			Standard Diameter	Clearance To Bore ①	Hydraulic Lifter Leakdown Rate ②
302-2V	1.60:1	0.020	0.8740- 0.8745	0.0007- 0.0027	5-50 Seconds Maximum— Measured at 1/16 inch plunger travel
302 Boss					
351-W					

① Wear Limit -0.005    ② 302 Boss—Mechanical Tappet

## VALVE SPRINGS

Engine	Valve Spring Pressure Lbs @ Specified Length		Valve Spring Free Length Approximate	Valve Spring Assembled Height Pad to Retainer	Valve Spring Out-of-Square (Maximum)
	Pressure	Wear Limit			
302-2V	71-79 @ 1.660 171-189 @ 1.230	64 @ 1.660 154 @ 1.230	1.97	1 5/8-1 21/32	5/64 (0.078)
302 Boss	88-96 @ 1.820 299-331 @ 1.320	79 @ 1.820 269 @ 1.320	2.03	1 13/16-1 27/32	
351-W	79-87 @ 1.790 204-226 @ 1.340	71 @ 1.790 184 @ 1.340	2.07	1 3/4-1 13/16	

## VALVES

Engine	To Valve Guide Clearance ①		Valve Stem to Rocker Arm Clearance		Valve Head Diameter		Valve Face Angle
	Intake	Exhaust	Allowable	Desired	Intake	Exhaust	
302-2V	0.0010-0.0027	0.0010-0.0027	0.067-0.167	0.067-0.117	1.773-1.783	1.442-1.457	44°
302 BOSS		0.0015-0.0032	Valve Lash Hot 0.025 Mechanical Tappet		2.2225-2.2375	1.7075-1.7125	
351W		0.0010-0.0027	0.083-0.183	0.083-0.113	1.834-1.852	1.533-1.548	

① Wear Limit 0.0055

## VALVES (Continued)

Engine	Valve Stem Diameter							
	Standard		0.003 Oversize		0.015 Oversize		0.030 Oversize	
	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust
302-2V	0.3416-	0.3411-	0.3446-	0.3441-	0.3566-	0.3561-	0.3716-	0.3711-
302 Boss	0.3423	0.3418	0.3453	0.3448	0.3573	0.3568	0.3723	0.3718
351-W								

**CAMSHAFT**

Engine	Lobe Lift ①		Theoretical Valve Lift		Camshaft		Camshaft Journal to Bearing Clearance	
	Intake	Exhaust	Intake	Exhaust	End Play	Wear Limit	Clearance	Wear Limit
302-2V	0.2303	0.2375	0.3680	0.3810		0.007	0.001-0.003	
302 Boss	0.290	0.290	0.477	0.477		0.009		0.006
351-W	0.260	0.278	0.418	0.448		0.007		

① Maximum allowable lobe lift loss (All engines) ..... 0.005

**CAMSHAFT (Continued)**

Item	Bearing	302-2V, 302 Boss, 351W	Item	Bearing	302-2V, 302 Boss, 351W
Camshaft Journal Diameter—Standard ①	(No 1)	2.0805-2.0815	Camshaft Bearings Inside	(No 1)	2.0825-2.0835
	(No 2)	2.0655-2.0665		(No 2)	2.0675-2.0685
	(No 3)	2.0505-2.0515		(No 3)	2.0525-2.0535
	(No 4)	2.0355-2.0365		(No 4)	2.0375-2.0385
	(No 5)	2.0205-2.0215		(No 5)	2.0225-2.0235
Camshaft Bearing Location ②	(No 1)	0.0050-0.0200			

① Camshaft journal maximum runout ..... 0.008  
 Camshaft journal maximum out-of-round ..... 0.001  
 ② Distance in inches that the front edge of the bearing is installed towards the rear from the front face of the cylinder block.

**CAMSHAFT DRIVE MECHANISM**

Crankshaft Sprocket Assembled Face Runout TIR (Maximum)	Timing Chain Deflection (Maximum)
0.006	0.500

**CAMSHAFT VALVE TIMING**

Engine	Intake Valve		Exhaust Valve	
	Opens	Closes	Opens	Closes
302-2V	0.004 Inch @ 16° BTC	0.006 Inch @ 70° ABC	0.002 Inch @ 52° BBC	0.005 Inch @ 24° ATC
302 Boss	0.014 Inch @ 40° BTC	0.014 Inch @ 80° ABC	0.014 Inch @ 84° BBC	0.014 Inch @ 36° ATC
351-W	0.004 Inch @ 11° BTC	0.006 Inch @ 65° ABC	0.004 Inch @ 68° BBC	0.006 Inch @ 22° ATC

**CYLINDER BLOCK**

Engine	Cylinder Bore Diameter ①	Cylinder Bore Diameter 0.003 OS	Tappet Bore Diameter	Main Bearing Bore Diameter	Cylinder Block Distributor Shaft Bearing Bore Diameter	Head Gasket Surface Flatness ②
302-2V	4.0004-4.0028	4.0028-4.0040	0.8752-0.8767	2.4412-2.4420	0.4525-0.4541	0.003 inch in any 6 inches or 0.007 inch Overall
302-Boss						
351-W	4.0000-4.0024	4.0024-4.0036		3.1922-3.1930	0.5155-0.5171	
① Maximum out-of-round ..... 0.001 Wear Limit ..... 0.005 Cylinder bore surface finish RMS ..... 15-35 ② Head gasket surface finish RMS ..... 90-150						

**CRANKSHAFT AND FLYWHEEL**

Engine	Main Bearing Journal Diameter ①	Main Bearing Journal Runout-Maximum	Main Bearing Journal Thrust Face Runout	Main Bearing Journal Taper Max	Thrust Bearing Journal Length	Main Bearing Surface Finish RMS Maximum	
						Journal	Thrust Face
302-2V	2.2482-2.2490						
302-Boss		0.004	0.001	0.0003 Per Inch	1.137-1.139	12	20 Front 20 Rear
351-W	2.9994-3.0002						
① Connecting rod and main bearing journal out-of-round maximum 0.0004 (all engine)							

## CRANKSHAFT AND FLYWHEEL (Continued)

Engine	Connecting Rod Journal Diameter ①	Connecting Rod Bearing Journal Maximum Taper	Crankshaft Free End Play	Crankshaft To Rear Face Of Block Runout TIR Max	Flywheel Clutch Face Runout	Flywheel OD Runout Transmission	
						Standard	Automatic
302-2V	2.1228-2.1236						
302 Boss	2.1222-2.1230	0.0004 Per Inch	0.004-0.008 ①	0.010	0.010	0.018	0.020
351-W	2.3103-2.3111						

① Wear Limit 0.012

② Connecting rod and main bearing journal out-of-round maximum 0.0004 (all engines)

## CRANKSHAFT BEARINGS

Engine	Connecting Rod Bearings				Main Bearings		
	To Crankshaft Clearance		Wall Thickness-Standard ①	To Crankshaft Clearance		Wall Thickness Standard ②	
	Desired	Allowable		Desired	Allowable		
302-2V	0.001-0.0015	0.0008-0.0026	0.0572-0.0577			No. 1 Bearing 0.0001-0.0018	No. 1 Bearing 0.0961-0.0966
302 Boss	0.0015-0.0025	0.0010-0.0028	0.0759-0.0764			All Others 0.0005-0.0024	All Others 0.0957-0.0962
351-W	0.001-0.0015	0.0008-0.0026	0.0572-0.0577			0.0013-0.003	0.0955-0.0958

① 0.002 U.S. Thickness ..... Add 0.0010 to Standard Thickness

② 0.002 U.S. Thickness ..... Add 0.0010 to Standard Thickness

## CONNECTING ROD

Engine	Piston Pin Bore Or Bushing ID	Connecting Rod Bearing Bore Diameter ①	Connecting Rod Length Center To Center	Connecting Rod Alignment Maximum Total Difference ②		Connecting Rod Assembly (Assembled To Crankshaft)	
				Twist	Bend	Side Clearance	Wear Limit
302-2V			5.0885-5.0915			0.010-0.020	0.023
302 Boss	0.9104-0.9112	2.2390-2.2398	5.1485-5.1515	0.012	0.004	0.013-0.025	0.028
351-W			5.9545-5.9575			0.010-0.020	0.023

① Connecting rod bearing bore maximum out-of-round and taper (All Engines) ..... 0.0004  
 ② Pin bushing and crankshaft bearing bore must be parallel and in the same vertical plane within the specified total difference at ends of 8-inch long bar measured 4 inches on each side of rod.

## PISTON

Engine	Diameter ①			Piston To Cylinder Bore Clearance	Piston Pin Bore Diameter	Ring Groove Width	
	Coded Red	Coded Blue	0.003 Oversize			Upper Compression Ring	Lower Compression Ring
302-2V	3.9984-3.9990	3.9996-4.0002	4.0008-4.0014	0.0018-0.0026	0.9123-0.9126	0.080-0.081	0.080-0.081
302-Boss	3.9968-3.9974	3.9980-3.9986	3.9992-3.9998	0.0034-0.0042	0.9122-0.9125		
351-W	3.9980-3.9986	3.9992-3.9998	4.0004-4.0010	0.0018-0.0026	0.9123-0.9126	0.1880-0.1890	

① Measured at the piston pin bore centerline at 90° to the pin bore.

## PISTON PIN

Engine	Length	Diameter		To Piston Clearance	To Connecting Rod Clearance
		Standard	0.001 Oversize		
302-2V	3.010-3.040			0.0002-0.0004 ①	
302-Boss	3.020-3.030	0.9119-0.9124	0.9130-0.9133	0.0006-0.0008 ①	
351-W	3.010-3.040			0.0003-0.0005 ①	

① Wear Limit 0.0008

② Wear Limit 0.0012

③ Interference Fit

**PISTON RINGS**

Engine	Ring Width		Side Clearance				Ring Gap Width		
	Compression Ring		Compression Ring ①		Oil Ring	Compression Ring		Oil Ring ②	
	Top	Bottom	Top	Bottom		Top	Bottom		
302-2V	0.077-	0.077-	0.002-	0.002-		0.010-	0.010-	0.015-	
302 Boss	0.078	0.078	0.004	0.004	Snug	0.020	0.020	0.069	
351-W									
① Wear Limit .....	0.006		② Steel Rail						

**OIL PUMP**

Engine	Rotor-Type Oil Pump Relief Valve Spring Tension Lbs @ Specified Length	Drive Shaft To Housing Bearing Clearance	Relief Valve Clearance	Rotor Assembly End Clearance	Outer Race To Housing (Radial Clearance)
302-2V	11.15-11.75 @ 1.704				
302-Boss	14.3-15.3 @ 1.70				
351-W	18.2-20.2 @ 2.49				

**APPROXIMATE OIL PAN CAPACITIES ①**

Engine	U.S. Measure	Imperial Measure	Engine	U.S. Measure	Imperial Measure
302-2V	5 Quarts		351-W	5 Quarts	4 Quarts
302 Boss	5 Quarts ②				

① Includes one quart with filter replacement

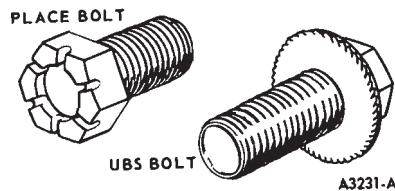
② Add one quart when equipped with oil cooler

**TORQUE LIMITS - FT LBS**

Item	Engine		
	302-2V	302 Boss	351-W
Cylinder Head Bolts Step 1	50	45	55
Step 2	60	55	65
Step 3	65-72	65-72	95-100
Oil Pan to Cylinder Block		9-11 (5/16 x 18) 7-9 (1/4 x 20)	
Intake Manifold Bolts	23-25	23-25 (5/16 Bolt) 28-32 (3/8 Bolt)	23-25
Exhaust Manifold Bolts		12-16	18-24
Water Outlet Housing		12-15	
Distributor Vacuum Control Valve		15-18	
Flywheel to Crankshaft		75-85	
Main Bearing Cap Bolts	60-70	Inner Bolts 60-70 Outer Bolts 35-40	95-105
Oil Pan Drain Plug	15-20	15-25	15-20
Oil Pump to Cylinder Block		23-28	
Oil Inlet Tube to Oil Pump		12-15	
Oil Pump Cover Plate		9-12	
Oil Filter Adapter to Block		60-100	
Oil Filter to Block Cartridge Type		With grease on gasket surface, hand-tighten until gasket contacts adapter face then tighten 1/2 turn more	
Element Type		20-25	
Cylinder Front Cover		12-15	
Water Pump Bolts		12-15	
Camshaft Sprocket to Camshaft		40-45	
Camshaft Thrust Plate to Block		9-12	
Vibration Damper to Crankshaft		70-90	
Crankshaft Pulley to Vibration Damper UBS Bolts Place Bolts		25-35 35-45	
Connecting Rod Nuts	19-24	40-45	40-45

**TORQUE LIMITS - FT LBS (Continued)**

Item	Engine		
	302-2V	302 Boss	351-W
Valve Rocker Arm Cover		3-5	
Fuel Pump to Cylinder Front Cover		20-24	
Rocker Arm Stud to Cylinder Head		85	
Rocker Arm Stud Lock Nut		25-35	
Rocker Arm Stud Nut	18-20 Ft-Lbs After Nut Contacts Shoulder		18-20 Ft-Lbs After Nut Contacts Shoulder
Thermactor Check Valve to Intake Manifold		16-19	
Thermactor Air Pump Adjusting Arm Bolt		16-20	
Thermactor Air Pump Mounting Bolts		16-26	
Thermactor Air Pump Drive Pulley to Pump Hub Bolts		7-9	
<b>Engine Supports</b>		<b>Car Line</b>	
Item	Ford and Meteor	Fairlane, Falcon and Montego	Mustang and Cougar
Engine Front Supports			
Insulator to Engine	35-50		
Insulator to Support Bracket	35-50		20-30
Mounting Bracket to Frame		20-30	
Engine Rear Supports Insulator to Transmission	40-50	30-45	Man. Trans. 20-30 Auto. Trans. 30-45
	20-30	30-50	25-35
Crossmember to Frame	70-100	50-70	10-20

**TORQUE LIMITS FOR VARIOUS SIZE BOLTS**

CAUTION: If any of the torque limits listed in this table disagree with any of those listed in the preceding tables, the limits listed in the preceding tables prevail.

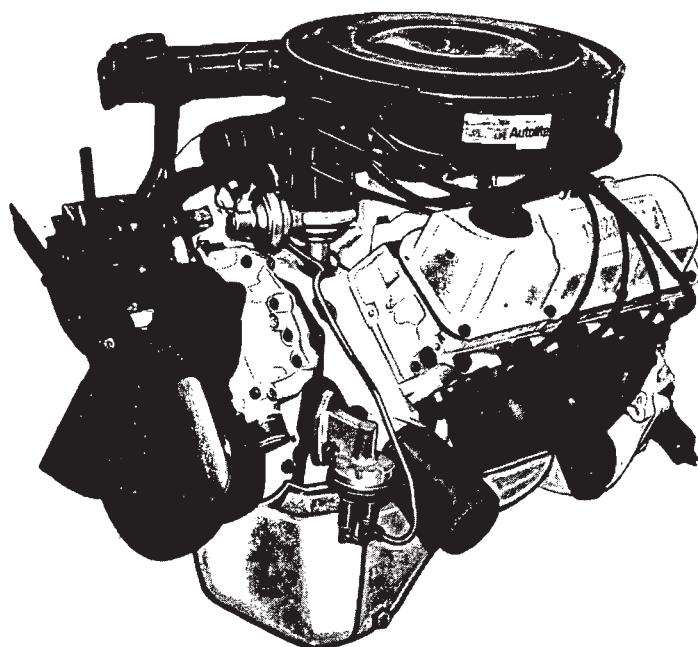
Size (Inches)	1/4-20	1/4-28	5/16-18	5/16-24	3/8-16	3/8-24
Torque (Ft-lbs)	6-9	6-9	12-15	15-18	23-28	30-35
Size (Inches)	7/16-14	7/16-20	1/2-13	1/2-20	9/16-18	5/8-18
Torque (Ft-lbs)	45-50	50-60	60-70	70-80	85-95	130-145

# PART 21-05 351 C Engines

Model Application - Fairlane, Montego, Mustang and Cougar			
COMPONENT INDEX	Page	COMPONENT INDEX	Page
<b>CAMSHAFT</b>		<b>ENGINE FRONT SUPPORTS</b>	
Bearing Removal and Installation .....	05-23	Installation .....	05-03
Bearing Bore Plug Removal and Installation .....	05-13	Removal .....	05-03
Camshaft Installation .....	05-12	<b>ENGINE REAR SUPPORTS</b>	
Camshaft Removal .....	05-11	Installation .....	05-03
<b>CLUTCH PILOT BUSHING</b>		Removal .....	05-03
Installation .....	05-17	<b>EXHAUST EMISSION CONTROL SYSTEM</b>	
Removal .....	05-17	Description .....	05-02
<b>CONNECTING ROD BEARING</b>		<b>EXHAUST MANIFOLD</b>	
Installation .....	05-15	Installation .....	05-06
Removal .....	05-15	Removal .....	05-06
<b>CRANKCASE VENTILATION SYSTEM</b>		<b>FLYWHEEL</b>	
Description .....	05-02	Installation .....	05-17
Installation .....	05-07	Removal .....	05-17
Removal .....	05-06	<b>INTAKE MANIFOLD</b>	
<b>CRANKSHAFT</b>		Installation .....	05-05
Front Seal Removal and Installation .....	05-09	Removal .....	05-05
Installation .....	05-21	<b>MAIN BEARING</b>	
Rear Seal Removal and Installation .....	05-14	Installation .....	05-14
Removal .....	05-21	Removal .....	05-14
<b>CYLINDER ASSEMBLY (SHORT BLOCK)</b>		<b>OIL FILTER</b>	
Assembly .....	05-24	Cartridge Type Removal and Installation .....	05-18
Disassembly .....	05-24	Element Type Removal and Installation .....	05-18
<b>CYLINDER BLOCK</b>		<b>OIL PAN</b>	
Assembly .....	05-24	Installation .....	05-19
Disassembly .....	05-24	Removal .....	05-18
<b>CYLINDER FRONT COVER AND TIMING CHAIN</b>		<b>OIL PUMP</b>	
Installation .....	05-11	Assembly .....	05-20
Removal .....	05-10	Disassembly .....	05-20
<b>CYLINDER HEAD</b>		Installation .....	05-19
Assembly .....	05-08	Removal .....	05-19
Disassembly .....	05-08	<b>PISTON AND CONNECTING ROD</b>	
Installation .....	05-07	Assembly .....	05-16
Removal .....	05-07	Disassembly .....	05-16
<b>ENGINE</b>		Installation .....	05-16
Assembly .....	05-25	Removal .....	05-15
Description .....	05-02	<b>ROCKER ARM AND ROCKER ARM COVER</b>	
Disassembly .....	05-24	Installation .....	05-04
Installation .....	05-20	Removal .....	05-04
Removal .....	05-20	<b>SPECIFICATIONS</b> .....	05-27

COMPONENT INDEX	Page	COMPONENT INDEX	Page
<b>VALVE</b> Valve Clearance Check .....	05-03	<b>VALVE SPRING RETAINER</b> Installation ..... Removal .....	05-09 05-08
<b>VALVE LIFTER</b> Assembly ..... Disassembly ..... Installation ..... Removal .....	05-13 05-13 05-13 05-13	<b>VALVE STEM SEAL</b> Installation ..... Removal .....	05-09 05-08
<b>VALVE SPRING</b> Installation ..... Removal .....	05-09 05-08	<b>WATER PUMP</b> Installation ..... Removal .....	05-09 05-09

## 1 DESCRIPTION



A3286-A

FIG. 1—Left Front View—351C Engine

### ENGINE

The 351C V-8 engine (Fig. 1) has a piston displacement of 351 cubic inches.

An engine identification tag is located under the ignition coil bracket. Refer to Part 21-01, Section 1 for engine tag code.

### EXHAUST EMISSION CONTROL SYSTEM

These engines use the Imco exhaust emission control system to keep exhaust gas contaminants at an acceptable level.

### CRANKCASE VENTILATION SYSTEM

The engine is equipped with a positive closed-type crankcase ventilation system directing the crankcase vapors to the intake manifold.

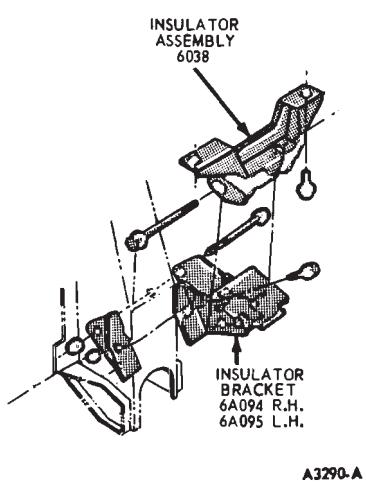
## 2 IN-VEHICLE ADJUSTMENTS AND REPAIRS

When installing nuts or bolts that must be torqued (refer to Section 5 for torque specifications), oil the

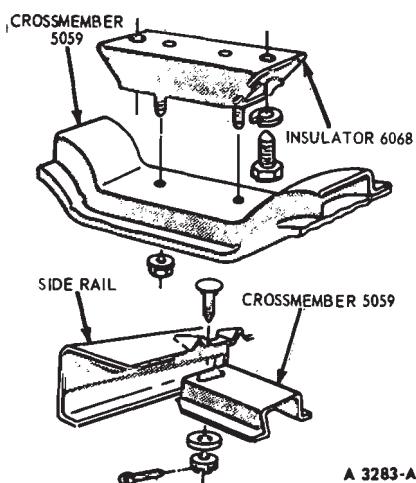
threads with light weight engine oil. Do not oil threads that require oil-resistant or water-resistant sealer.

Refer to Part 21-01, Section 3 for cleaning and inspection procedures.

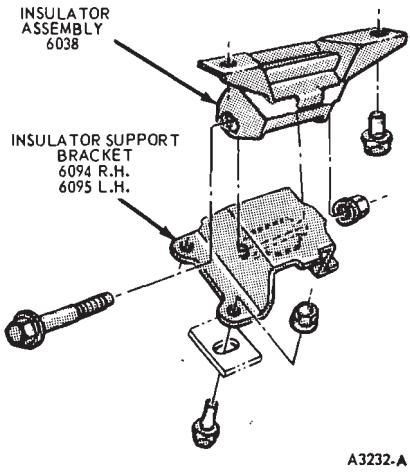
Refer to Part 21-01, Section 1 for



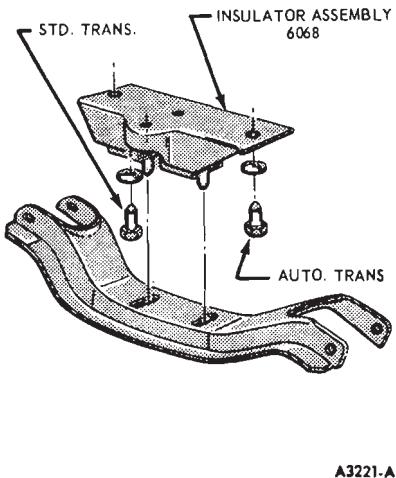
**FIG. 2—Engine Front Supports—Mustang and Cougar**



**FIG. 5—Engine Rear Support—Fairlane and Montego**



**FIG. 3—Engine Front Support—Fairlane and Montego**



**FIG. 4—Engine Rear Support—Mustang and Cougar**

## ENGINE REAR SUPPORT

The rear support is located at the transmission extension housing (Figs. 4 and 5).

### REMOVAL

1. Remove the support insulator to crossmember attaching nuts.
2. Remove the support insulator to transmission extension housing bolts and lock washers.
3. Raise the transmission with a floor jack. Remove the support insulator and retainer.

### INSTALLATION

1. Position the support insulator and retainer on the transmission extension housing.

2. Install the support insulator to transmission extension housing bolts and lock washers. Tighten the bolts to specifications. Lower the transmission.

3. Install the support insulator to crossmember attaching nuts. Tighten the nuts to specifications.

## VALVE CLEARANCE CHECKING PROCEDURE

The valve arrangement on the left bank is E-I-E-I-E-I-E-I and on the right bank is I-E-I-E-I-E-I-E.

A 0.060-inch shorter push rod or a 0.060-inch longer push rod are available for service to provide a means of compensating for dimensional changes in the valve mechanism. Refer to the Master Parts List or the specifications for the pertinent color code.

Valve stem to valve rocker arm clearance should be within specifications with the hydraulic lifter completely collapsed. Repeated valve reconditioning operations (valve and/or valve seat refacing) will decrease the clearance to the point that if not compensated for, the hydraulic valve lifter will cease to function and the valve will be held open.

To determine whether a shorter or a longer push rod is necessary, make the following check:

1. Disconnect the brown lead (I terminal) and the red and blue lead (S terminal) at the starter relay. Install an auxiliary starter switch between the battery and S terminals of the Starter relay. Crank the engine with the ignition switch OFF until the No. 1 piston is on TDC after the compression stroke.

## ENGINE FRONT SUPPORTS

The front supports are located on each side of the cylinder block (Figs. 2 and 3). The procedures given apply to either a right or left installation.

### REMOVAL

1. Remove the fan shroud attaching bolts.
2. Remove the through bolt and lock nut attaching the insulator to the insulator support bracket (Figs. 2 and 3).
3. Raise the engine slightly with a jack and a wood block placed under the oil pan.
4. Remove the engine insulator assembly to cylinder block attaching bolts and lock washers. Remove the engine insulator assembly.

### INSTALLATION

1. Position the engine insulator assembly to the cylinder block and install the attaching bolts and lock washers. Tighten the bolts to specifications.

2. Lower the engine into position, install the engine insulator assembly to insulator support bracket through bolt and remove the jack and wood block.

3. Install the engine insulator assembly to insulator support bracket nuts. Tighten the nut to specifications.

4. Install the fan shroud attaching bolts.

2. With the crankshaft in the positions designated in Steps 3, 4, and 5, position the hydraulic lifter compressor tool on the rocker arm. Slowly apply pressure to bleed down the hydraulic lifter until the plunger is completely bottomed (Fig. 6). Hold the lifter in this position and check the available clearance between the rocker arm and the valve stem tip with a feeler gauge.

If the clearance is less than specifications, install an undersize push rod. If the clearance is greater than specifications, install an oversize push rod.

3. With the No. 1 piston on TDC at the end of the compression stroke, POSITION A in Fig. 7, check the following valves:

No. 1 Intake No. 1 Exhaust  
No. 4 Intake No. 3 Exhaust  
No. 8 Intake No. 7 Exhaust

4. After these valves have been checked, rotate the crankshaft to POSITION B in Fig. 7, and check the following valves:

head before tightening the fulcrum bolts. Tighten the fulcrum bolt to specification. Check the valve clearance following the procedures under Valve Clearance Checking Procedure.

3. Clean the valve rocker arm cover(s) and the cylinder head gasket surface(s). Apply oil-resistant sealer to one side of new cover gasket(s). Lay the cemented side of the gasket(s) in place in the cover(s).

4. Position the cover(s) on the cylinder head(s). Make sure the gasket seats evenly all around the head. Install the bolts. The cover is tightened in two steps. Tighten the bolts to specifications. Two minutes later, tighten the bolts to the same specifications.

If the right cover was removed, install the crankcase ventilation regulator valve.

Install the air cleaner and intake duct assembly.

5. Install the spark plug wires in the bracket on the valve rocker arm cover(s). Connect the spark plug wires.

6. Start the engine and check for leaks.

## INTAKE MANIFOLD

The Intake Manifold Assembly is shown in Fig. 9.

### REMOVAL

1. Remove the air cleaner and intake duct.

2. Disconnect the high tension lead and wires from the coil. Disconnect the engine wire loom and position it out of the way.

3. Disconnect the spark plug wires from the spark plugs by grasping, twisting and pulling the moulded cap only. Remove the wires from the harness brackets on the valve rocker arm covers. Remove the distributor cap and spark plug wire assembly.

4. Remove the carburetor fuel inlet line.

5. Remove the heater hoses from the retainers and position the hoses out of the way.

6. Remove the ignition coil and bracket.

7. Disconnect the crankcase emission hose at the right rocker arm cover.

8. Disconnect the vacuum lines from the intake manifold. Remove the bolts attaching the vacuum outlet to the left hand rocker arm covers, if so equipped.

9. Disconnect the distributor vacu-

um hoses from the distributor. Remove the distributor hold down bolt and remove the distributor.

10. Disconnect the accelerator linkage and transmission downshift linkage, if so equipped, and position out of the way.

11. Remove the carburetor.

12. Remove the manifold attaching bolts. Remove the manifold. Remove and discard the intake manifold gasket and seals.

13. If the manifold assembly is to be disassembled, identify all vacuum hoses before disconnecting them.

### INSTALLATION

1. If the intake manifold assembly was disassembled, install the engine identification tag.

2. Clean the mating surfaces of the intake manifold, cylinder heads and cylinder block. Use a suitable solvent to remove all traces of oil.

3. Position new seals on the cylinder block and press the seal locating extensions into the holes in the mating surface.

Apply non-hardening sealer at the four junction points of the seals and cylinder heads. Position the intake manifold gasket onto the block and cylinder heads with the alignment notches under the dowels on the cylinder heads. Be sure the holes in the gasket are aligned with the holes in the cylinder head.

4. Carefully lower the intake manifold into position on the cylinder block and cylinder heads.

5. Be sure the holes in the manifold gaskets and manifold are in alignment. Install the intake manifold attaching bolts. Tighten the intake manifold bolts in three steps (Fig. 10).

Tighten all bolts in sequence to 8-10 ft-lb.

Tighten all bolts in sequence to 15-20 ft-lb.

Tighten all bolts in sequence to specifications.

After completing the remaining assembly steps, operate the engine until it reaches normal operating temperature then re-tighten the manifold bolts in sequence to specifications.

6. Install the carburetor and gasket.

7. Rotate the crankshaft damper until the No. 1 piston is on TDC at the end of the compression stroke. Position the distributor in the block with the rotor at the No. 1 firing position and the points just open. Install the hold down clamp.

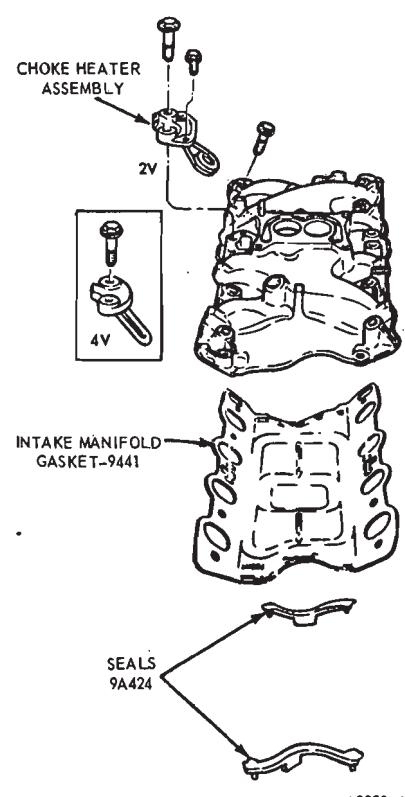


FIG. 9—Intake Manifold Assembly

8. Install the accelerator linkage and transmission downshift rod, if so equipped.

9. Install the ignition coil.

10. Connect the vacuum lines at the manifold. Install the manifold vacuum outlet attaching bolts at the left hand rocker arm cover, if so equipped.

11. Position the engine wire loom under the hold down clips on the left rocker arm cover and connect the wires at the ignition coil, water temperature sending unit and throttle solenoid.

12. Connect the crankcase emission line at the right hand rocker arm cover.

13. Install the heater hoses in the retainers.

14. Connect the fuel pump to carburetor fuel line at the carburetor.

15. Install the distributor cap. Position the spark plug wires in the harness brackets on the valve rocker arm covers and connect the wires to the spark plugs.

16. Start the engine and check for leaks. Adjust the ignition timing and connect the distributor vacuum lines.

17. When engine temperature has stabilized, adjust idle mixture and speed. Retorque the intake manifold

to specifications.

18. Install the air cleaner assembly and re-check idle speed.

## EXHAUST MANIFOLD

### REMOVAL

1. If a right hand exhaust manifold is being removed, remove the air cleaner, intake duct and heat stove.

2. If a left hand exhaust manifold is being removed, remove the oil filter.

On vehicles equipped with a column selector and automatic transmission,

disconnect the selector lever cross shaft for clearance.

On vehicles with a manual transmission, disconnect the clutch linkage cross shaft for clearance.

3. Disconnect the muffler inlet pipe at the exhaust manifold.

4. Remove the exhaust manifold attaching bolts and remove the manifold.

### INSTALLATION

1. Clean the mating surfaces of the exhaust manifold and cylinder head. Clean the mounting flange of the ex-

haust manifold and muffler inlet pipe.

2. Apply graphite grease to the mating surface of the exhaust manifold.

3. Position the exhaust manifold on the head and install the attaching bolts. Working from the center to the ends, tighten the bolts to specifications.

4. Connect the muffler inlet pipes at the exhaust manifold. Tighten the attaching nuts to specifications.

5. If a left hand exhaust manifold is being installed, install the oil filter.

On a vehicle with an automatic transmission and column selector, connect the selector cross shaft at the chassis and cylinder block.

On a vehicle with a manual transmission, connect the clutch linkage cross shaft at the chassis and cylinder block.

6. If a right hand exhaust manifold is being replaced, install the air cleaner heat stove. Install the air cleaner and intake duct.

7. Start the engine and check for exhaust leaks.

## CRANKCASE VENTILATION SYSTEM

The crankcase ventilation system components are shown in Fig. 11.

### REMOVAL

#### Filter Only

1. Remove the ventilation system air intake hose at the air cleaner. Remove the air cleaner cover.

2. Remove the filter retaining clip and remove the filter.

#### Complete System

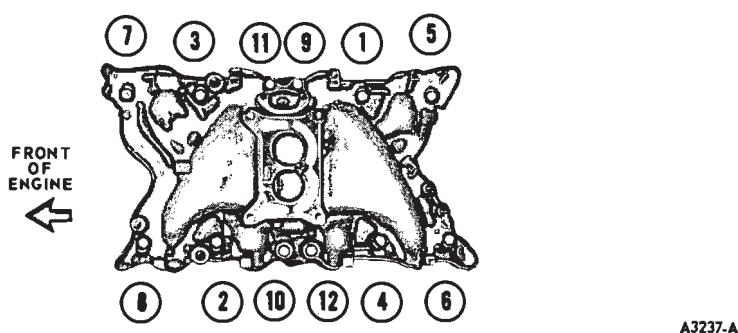
1. Remove the ventilation system air intake hose from the air cleaner and the oil filler cap.

2. Remove the air cleaner and intake duct assembly.

3. Disconnect the crankcase vent hose from the carburetor, regulator valve and hot idle compensator (if so equipped).

4. Pull the regulator valve out of the valve rocker arm cover or combustion arrester mounting grommet. On vehicles equipped with a crankcase storage fuel evaporative emission system, remove the combustion arrester from the rocker arm cover.

5. Remove the crankcase ventilation filter from the air cleaner body.



A3237-A

FIG. 10—Intake Manifold Torque Sequence

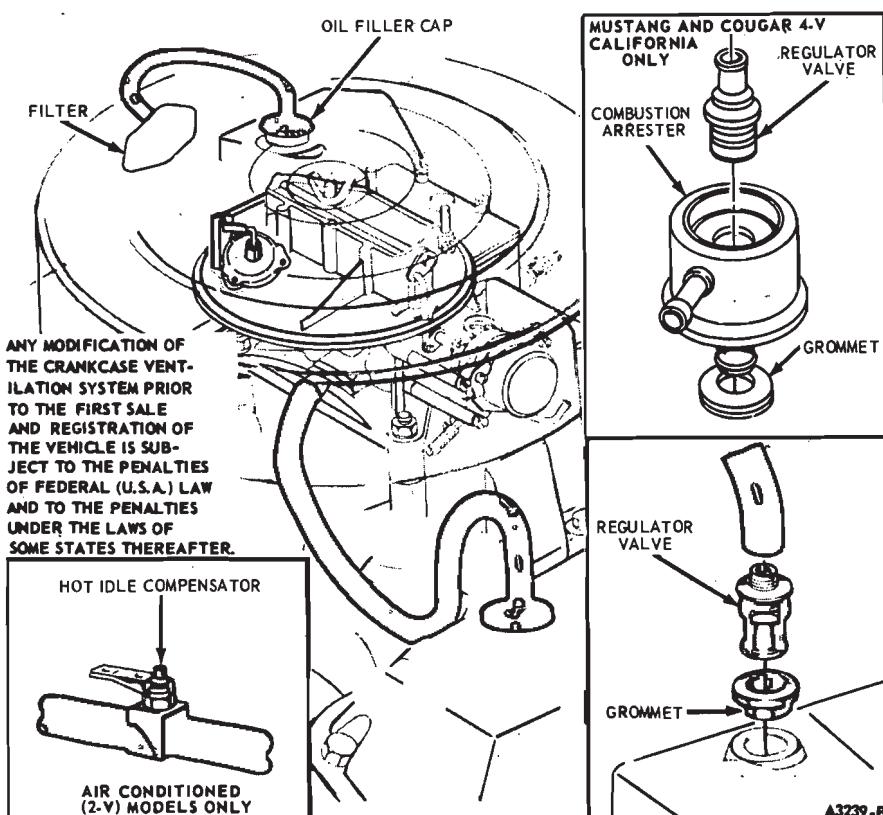


FIG. 11—Crankcase Ventilation System

## INSTALLATION

### Filter Only

- Position the filter in the air cleaner body. Install the filter retaining clip.
- Install the air cleaner cover and the ventilation system air intake hose at the air cleaner.

### Complete System

- Install the crankcase ventilation filter in the air cleaner body.
- On a vehicle equipped with a crankcase storage fuel evaporative emission system, insert the combustion arrester into the valve rocker arm cover and connect the vapor line from the fuel tank.
- Insert the regulator valve into the valve rocker arm cover or combustion arrester mounting grommet.
- Connect the vent hose to the carburetor, regulator valve and hot idle compensator (if so equipped).
- Install the air cleaner and intake duct assembly.
- Install the ventilation system air intake hose to the air cleaner and the oil filler cap.
- Start the engine and check for leaks.

## CYLINDER HEADS

If a cylinder head is to be replaced, follow the procedures under Cylinder Head Disassembly and Assembly, and transfer all valves, springs, spark plugs, etc., to the new cylinder head. Clean and inspect all parts, reface the valves (refer to Part 21-01) and check all assembly clearances before assembling the new or used parts to the new cylinder head.

## REMOVAL

- Remove the intake manifold and carburetor as an assembly following the procedure under Intake Manifold Removal.

- Remove the rocker arm cover(s).

If the left cylinder head is to be removed on a vehicle with an air conditioner, isolate and remove the compressor as outlined in Group 34.

If the left cylinder head is to be removed on a vehicle with power steering, disconnect the power steering pump bracket from the left cylinder head and remove the drive belt from the pump pulley. Position the power steering pump out of the way and in a position that will prevent the oil from

draining out.

- If the right cylinder head is to be removed, remove the alternator mounting bracket through bolt and air cleaner inlet duct from the right cylinder head assembly. Remove the ground wire at the rear of the cylinder head.
- Disconnect the exhaust manifold(s) from the muffler inlet pipe(s).
- Loosen the rocker arm fulcrum bolts so that the rocker arms can be rotated to the side. Remove the push rods in sequence (Fig. 12) so that they may be installed in their original positions.
- Remove the cylinder head attaching bolts and lift the cylinder head off the block. Remove and discard the cylinder head gasket.

## INSTALLATION

- Clean the cylinder head, intake manifold, valve rocker arm cover and cylinder head gasket surfaces. If the cylinder head was removed for a cylinder head gasket replacement, check the flatness of the cylinder head and block gasket surfaces.

2. Position the new cylinder head gasket over the cylinder dowels on the block. Position the cylinder head on the block and install the attaching bolts.

3. The cylinder head bolts are tightened in three progressive steps. Tighten all the bolts in sequence (Fig. 13) to 50 ft-lbs., then to 60 ft-lbs. and finally to specifications. When cylinder head bolts have been tightened following this procedure, it is not necessary to retorque the bolts after extended operation. However, the bolts may be checked and retorqued if desired.

4. Clean the push rods in a suitable solvent. Blow out the oil passage in the push rod with compressed air. Check the ends of the push rods for nicks, grooves, roughness or excessive wear. Visually check the push rods for straightness or check push rod runout with a dial indicator. If runout exceeds the maximum limit at any point, discard the rod. **Do not attempt to straighten push rods.**

5. Lubricate and install the push rods in their original positions. Apply Lubriplate or equivalent to the valve stem tips.

6. Lubricate and install the rocker arms following procedures under Valve Rocker Arm Installation.

7. Connect the exhaust manifold(s) at the muffler inlet pipe(s). Tighten the nuts to specifications.

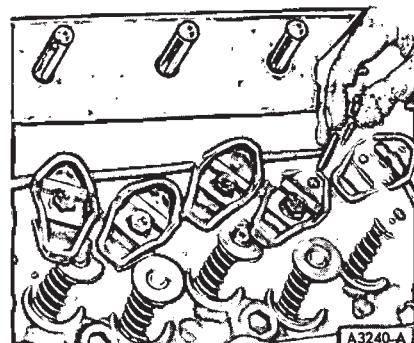


FIG. 12—Removing Valve Push Rod

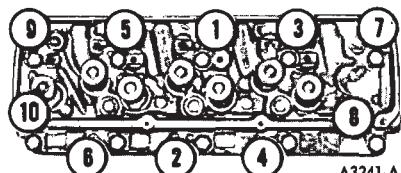


FIG. 13—Cylinder Head Bolt Torque Sequence

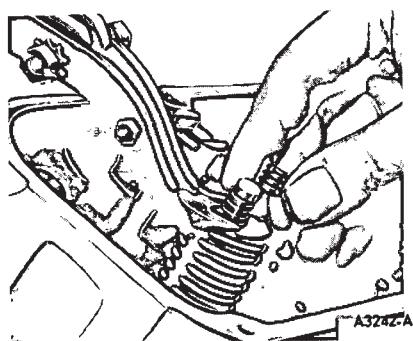


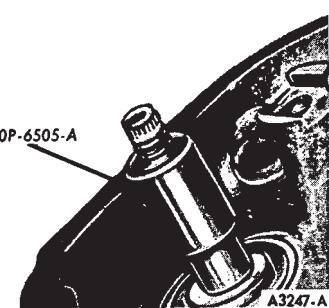
FIG. 14—Compressing Valve Spring on Bench

8. If the right cylinder head was removed, install the alternator mounting bracket through bolt and air cleaner inlet duct on the right cylinder head assembly. Connect the ground wire at the rear of the cylinder head. Adjust the drive belt tension to specifications.

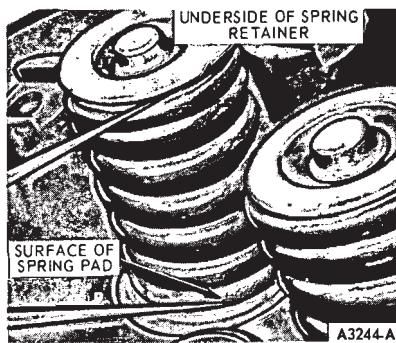
9. Apply oil-resistant sealer to one side of new cover gasket(s). Lay the cemented side of the gasket(s) in place in the cover(s). Install the valve rocker arm cover(s).

If the left cylinder head was removed on a vehicle with an air conditioner, install the compressor as outlined in Group 34.

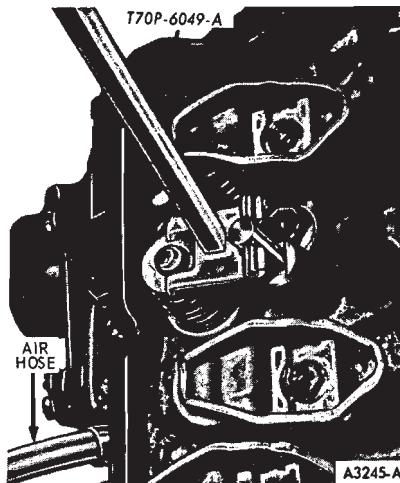
If the left cylinder head was removed on a vehicle with power steering, install the drive belt and power steering pump bracket. Install the bracket attaching bolts. Adjust the



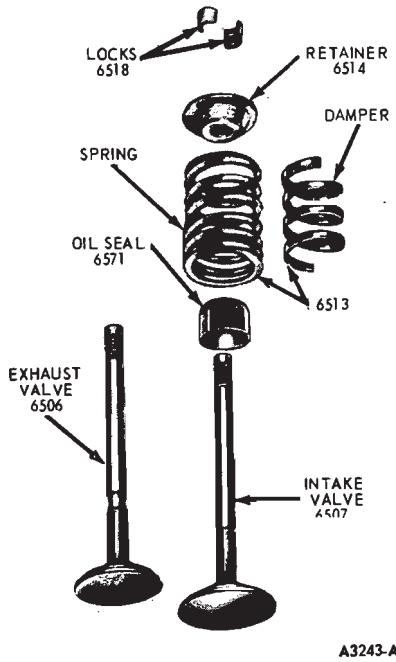
**FIG. 15—Removing Valve Stem Burrs**



**FIG. 17—Valve Spring Assembled Height**



**FIG. 18—Compressing Valve Spring in Chassis**



**FIG. 16—Valve and Related Parts**

drive belt to specifications.

10. Install the intake manifold and related parts following the procedure under Intake Manifold Installation.

#### DISASSEMBLY

1. Remove the exhaust manifolds and the spark plugs.

2. Clean the carbon out of the cylinder head combustion chambers before removing the valves.

3. Compress the valve springs (Fig. 14). Remove the spring retainer locks and release the spring.

4. Remove the spring retainer, spring and stem seal. Discard the valve stem seals. Remove any burrs from the valve stem with Tool T70P-6505-A as shown in Fig. 15 to prevent damage to the valve guide bore. Re-

move the valve. Identify all valve parts.

5. Clean, inspect and repair the cylinder head as required, or transfer all usable parts to a new cylinder head.

#### ASSEMBLY

All valves, valve stems and valve guides are to be lubricated with heavy engine oil MS. The valve tips are to have Lubriplate or equivalent applied. The lubricant is to be applied before installation.

1. Clean the spring retainer lock grooves on the valves to remove any loose material left by the valve stem de-burring tool.

2. Lubricate the valve guide and valve stem with heavy engine oil MS.

3. Install each valve (Fig. 16) in the port from which it was removed or to which it was fitted. Install a new stem seal on the valve.

4. Install the valve spring over the valve, and then install the spring retainer. Compress the spring and install the retainer locks (Fig. 14).

5. Measure the assembled height of the valve spring from the surface of the cylinder head spring pad to the underside of the spring retainer with dividers (Fig. 17). Check the dividers against a scale. If the assembled height is greater than specifications, install the necessary 0.030-inch thick spacer(s) between the cylinder head spring pad and the valve spring to bring the assembled height to the recommended height.

**Do not install the spacers unless necessary. Use of spacers in excess of recommendations will result in overstressing the valve springs and overloading the camshaft lobes which could lead to spring breakage and/or worn camshaft lobes.**

6. Install the exhaust manifolds and the spark plugs.

#### VALVE SPRING, RETAINER AND STEM SEAL

Broken valve springs or damaged valve stem seals and retainers may be replaced without removing the cylinder head, provided damage to the valve or valve seat has not occurred.

#### REMOVAL

1. Disconnect the automatic choke heat chamber air inlet hose from the inlet tube near the right valve rocker arm cover.

2. Remove the air cleaner and intake duct assembly.

To remove the right valve rocker arm cover, remove the crankcase ventilation regulator valve from the valve rocker arm cover.

3. Remove the valve rocker arm cover and the applicable spark plug.

4. Remove the valve rocker arm fulcrum bolts, fulcrum seats, valve rocker arms and push rods from the applicable cylinder.

5. Install an air line with an adapter in the spark plug hole and turn on the air supply.

6. Install the compressor tool as shown in Fig. 18. Compress the valve spring and remove the retainer locks, spring retainer and valve spring.

7. Remove and discard the valve stem seal (Fig. 19).

8. If air pressure has forced the piston to the bottom of the cylinder, any removal or air pressure will allow the valve(s) to fall into the cylinder. A rubber band, tape or string wrapped around the end of the valve stem will prevent this condition and will still allow enough travel to check the valve.

for binds.

## INSTALLATION

- Inspect the valve stem for damage. Rotate the valve and check the valve stem tip for eccentric movement during rotation. Move the valve up and down through normal travel in the valve guide and check the stem for binds. If the valve has been damaged, it will be necessary to remove the cylinder head for repairs as outlined in Part 21-01, Section 2.
- If the condition of the valve proved satisfactory, hold the valve in the closed position and apply the air pressure within the cylinder.
- Lubricate the valve stem with heavy engine oil MS.

4. Install a new valve stem seal (Fig. 19). Place the spring in position over the valve and install the valve spring retainer. Compress the valve spring and install the valve spring retainer locks. Remove the compressor tool and stud nut. Turn off the air and remove the air line adapter.

5. Lubricate and install the push rod. Apply Lubriplate or equivalent to the tip of the valve stem.

6. Lubricate the push rod socket, fulcrum seat and the valve pad of the rocker arm with heavy engine oil MS.

7. Position the No. 1 piston on TDC at the end of the compression stroke, POSITION A in Fig. 7, and install the rocker arms, fulcrum seats and fulcrum bolts on the following valves:

- No. 1 Intake No. 1 Exhaust
- No. 4 Intake No. 3 Exhaust
- No. 8 Intake No. 7 Exhaust

Position the crankshaft in POSITION B shown in Fig. 7, and install the rocker arms, fulcrum seats and fulcrum bolts on the following valves:

- No. 3 Intake No. 2 Exhaust
- No. 7 Intake No. 6 Exhaust

Position the crankshaft in POSITION C shown in Fig. 7, and install the rocker arms, fulcrum seats and fulcrum bolts on the following valves:

- No. 2 Intake No. 4 Exhaust
- No. 5 Intake No. 5 Exhaust
- No. 6 Intake No. 8 Exhaust

Be sure that the fulcrum seat base is inserted in its slot on the cylinder head before tightening the fulcrum bolt. Tighten the fulcrum bolts to specifications.

8. Clean and install the rocker arm cover.

If the right cover was removed, install the crankcase ventilation regulator valve.

- Install the spark plug and con-

nect the spark plug wires.

- Install the air cleaner and intake duct assembly.
- Connect the automatic choke heat chamber air inlet hose.

## WATER PUMP

### REMOVAL

1. Drain the cooling system and disconnect the battery.

2. Remove the fan shroud attaching bolts and position the shroud rearward.

3. Remove the fan and spacer from the water pump shaft.

4. Remove the air conditioner compressor drive belt lower idler pulley and compressor mount to water pump bracket, if so equipped.

5. Loosen the alternator and remove the drive belt.

6. If equipped with power steering, loosen the power steering pump and remove the drive belt.

7. Remove the water pump pulley.

8. Remove alternator bracket from water pump and position it out of the way.

9. If equipped with power steering, remove the power steering pump bracket from the water pump and position it out of the way.

10. Remove the heater hose from the water pump.

11. Disconnect the lower radiator hose at the water pump.

12. Remove the water pump attaching bolts and remove the water pump.

## INSTALLATION

Before a water pump is re-installed, check it for damage. If it is damaged, replace it.

1. Remove all gasket material from the mounting surfaces of the cylinder front cover and water pump.

2. Position a new gasket, coated on both sides with sealer, on the cylinder front cover; then install the pump. Coat the threads of the attaching screws with oil-resistant sealer and install the screws. Tighten the attaching screws to specifications.

3. Install the air conditioner compressor to water pump bracket and lower idler pulley, if so equipped.

4. Position the alternator bracket and power steering pump bracket, if so equipped, on the water pump and install the bracket bolts.

5. Position the water pump pulley on the water pump shaft and install the drive belts.

6. Place the fan shroud over the pulley and install the fan and spacer.

7. Install the fan shroud attaching bolts.

8. Adjust the drive belts to specifications.

9. Connect the lower radiator hose at the water pump.

10. Connect the heater hose at the water pump.

11. Connect the battery cable. Fill and bleed the cooling system. Operate the engine until normal operating temperature has been reached and check for leaks.

## FRONT OIL SEAL

### REMOVAL

1. Remove the bolts attaching the fan shroud to the radiator.

2. Remove the fan and spacer bolts from the water pump shaft. Remove the fan, spacer and shroud.

3. Loosen the alternator, power steering and air conditioner drive belts, if so equipped. Remove the

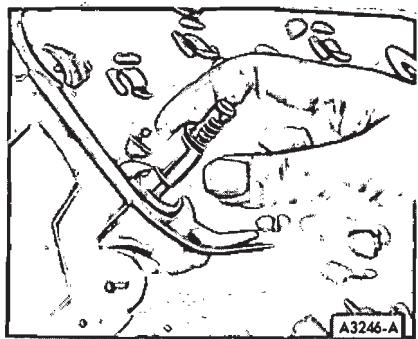


FIG. 19—Removing or Installing Valve Stem Seal

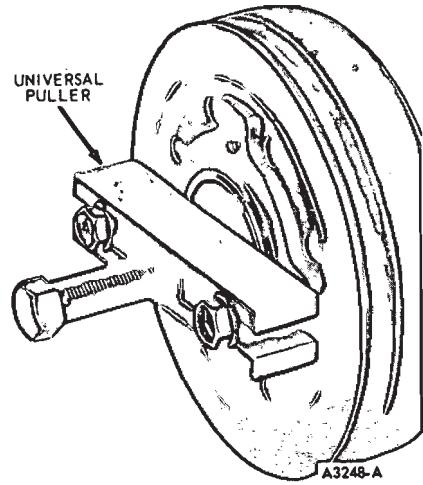


FIG. 20—Removing Crankshaft Vibration Damper

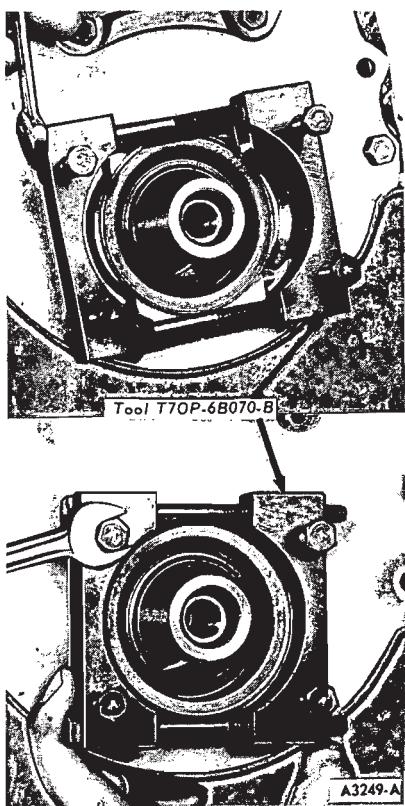


FIG. 21—Removing Front Crankshaft Seal

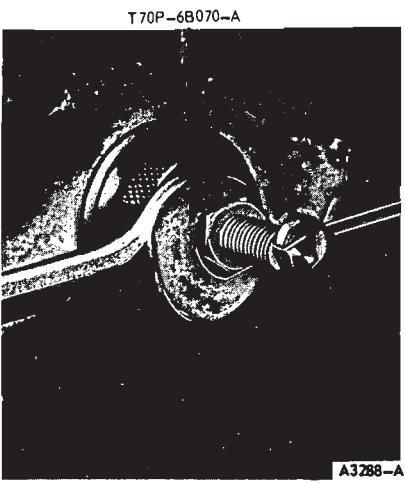


FIG. 22—Installing Front Crankshaft Seal

drive belts.

4. Remove the crankshaft pulley from the vibration damper. Remove the damper attaching screw and washer. Install the puller on the crankshaft vibration damper (Fig. 20) and remove the vibration damper.

5. Place the front seal removing tool onto the front cover over the front seal as shown in Fig. 21. Tighten the two through bolts to force the

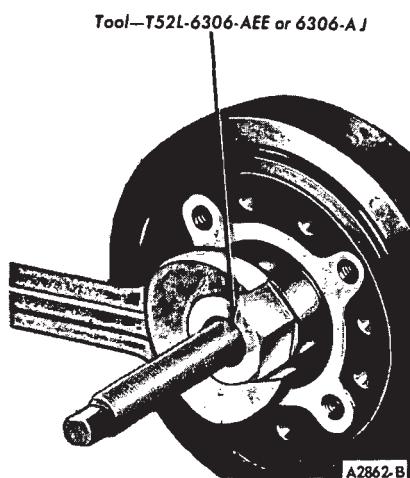


FIG. 23—Installing Crankshaft Vibration Damper

seal puller under the seal flange.

6. Alternately tighten the four puller bolts a half turn at a time as shown in Fig. 21 to pull the front oil seal from the front cover.

#### INSTALLATION

- Coat a new front oil seal with Lubriplate or equivalent and place it onto the front oil seal alignment and installation sleeve as shown in Fig. 22. Place the sleeve and seal onto the end of the crankshaft and push it toward the engine until the seal starts into the front cover.

- Place the installation screw, washer and nut onto the end of the crankshaft. Thread the screw into the crankshaft. Tighten the nut against the washer and installation sleeve to force the seal into the front cover. Remove the installation tool from the crankshaft.

- Apply Lubriplate or equivalent to the oil seal rubbing surface of the vibration damper inner hub to prevent damage to the seal. Apply a white lead and oil mixture to the front of the crankshaft for damper installation.

- Line up the crankshaft vibration damper keyway with the key on the crankshaft. Install the vibration damper on the crankshaft (Fig. 23). Install the cap screw and washer. Torque the screw to specifications. Install the crankshaft pulley.

- Install the alternator, power steering pump and air conditioner belts, if so equipped.

- Position the fan shroud over the water pump pulley. Install the fan and spacer. Install the fan shroud attaching screws.



FIG. 24—Aligning Timing Marks

- Adjust the drive belts to specification.

#### CYLINDER FRONT COVER AND TIMING CHAIN

##### REMOVAL

- Drain the cooling system and disconnect the battery.

- Remove the fan shroud attaching bolts.

- Remove the fan and spacer from the water pump shaft.

- If equipped with air conditioning, loosen the lower idler pulley and remove the compressor drive belt.

- Loosen the alternator and remove the drive belt.

- If equipped with power steering, loosen the power steering pump and remove the drive belt.

- Remove the water pump pulley.

- Remove the alternator to water pump bracket. Position the alternator out of the way.

- If equipped with power steering, remove the power steering pump bracket from the water pump and cylinder head. Position the pump out of the way.

- If equipped with air conditioning, remove the compressor to water pump bracket and lower idler pulley.

- Remove the heater hose and lower radiator hose from the water pump.

- Remove the crankshaft pulley from the crankshaft vibration damp-

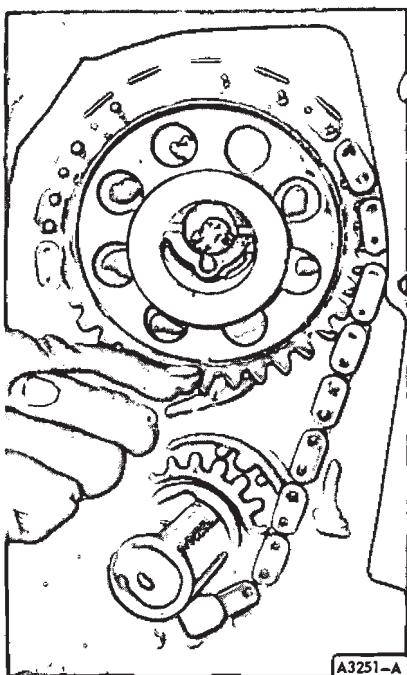


FIG. 25—Removing or Installing Timing Chain

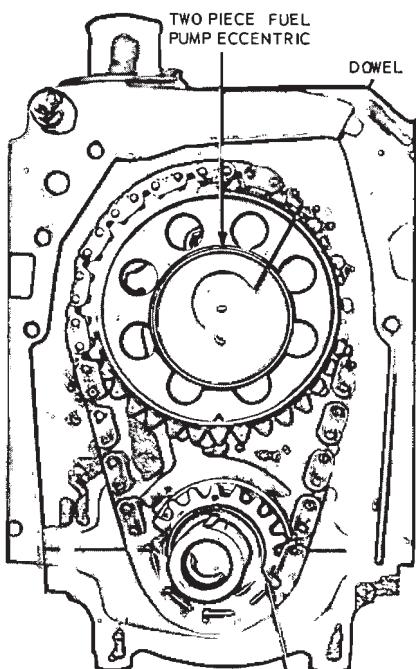


FIG. 26—Fuel Pump Eccentric and Front Oil Slinger Installed

er. Remove the vibration damper attaching screw. Install the puller on the crankshaft vibration damper (Fig. 20) and remove the vibration damper.

13. Remove the timing pointer.

14. Remove the bolts attaching the front cover and water pump to the cylinder block. Remove the front cover and water pump assembly.

15. Disconnect the fuel pump outlet line from the fuel pump. Remove the fuel pump attaching bolt and nut and lay the pump to one side with the flexible fuel line still attached.

16. Discard the cylinder front cover gasket and oil pan seal. Remove the crankshaft front oil slinger.

17. Check the timing chain deflection (refer to Part 21-01, Section 1).

18. Crank the engine until the timing marks on the sprockets are positioned as shown in Fig. 24.

19. Remove the camshaft sprocket cap screw, washer and two piece fuel pump eccentric. Slide both sprockets and the timing chain forward, and remove them as an assembly (Fig. 25).

## INSTALLATION

1. Position the sprockets and timing chain on the camshaft and crankshaft (Fig. 26). Be sure the timing marks on the sprockets are positioned as shown in Fig. 20.

2. Install the two piece fuel pump eccentric, washers and camshaft sprocket cap screw. Torque the sprocket cap screw to specifications. Be sure the outer eccentric sleeve rotates freely.

Install the crankshaft front oil slinger (Fig. 26).

3. Coat a new fuel pump gasket with oil-resistant sealer and position the fuel pump and gasket on the cylinder block with pump arm resting on the eccentric outer sleeve. Install the pump attaching bolt and nut and tighten to specification. Connect the fuel pump outlet line.

4. Remove the front crankshaft seal from the cylinder front cover with the tool shown in Fig. 21. Clean the cylinder front cover and the engine block gasket surfaces.

5. Coat the gasket surfaces of the block and cover with sealer, and position a new gasket on the cylinder block alignment dowels.

6. Position the cylinder front cover and water pump assembly on the cylinder block alignment dowels.

7. Coat the threads of the attaching bolts with oil-resistant sealer and install the timing pointer and attaching bolts. Torque the bolts to specifications.

8. Install the front crankshaft seal into the cylinder front cover with the tool shown in Fig. 22.

9. Apply Lubriplate or equivalent to the oil seal rubbing surface of the vibration damper inner hub to prevent damage to the seal. Apply a white lead and oil mixture to the front of

the crankshaft for damper installation.

10. Line up the crankshaft vibration damper keyway with the key on the crankshaft. Install the vibration damper on the crankshaft (Fig. 23). Install the cap screw and washer. Tighten the cap screw to specifications. Install the crankshaft pulley.

11. Connect the heater hose and the lower radiator hose at the water pump.

12. If equipped with air conditioning, install the lower idler pulley and compressor to water pump bracket.

13. If equipped with power steering, install the power steering pump brackets.

14. Install the alternator and brackets.

15. Position the water pump pulley on the water pump shaft and install the drive belts.

16. Place the fan shroud over the pulley and install the fan and spacer.

17. On a Mustang or Cougar, install the fan shroud attaching bolts.

18. Adjust the drive belts to specifications.

19. Raise the vehicle. Remove the oil pan and install new gaskets and seals following procedures under Oil Pan Removal and Installation.

20. Lower the vehicle. On a Fairlane or Montego install the fan shroud attaching bolts.

21. Fill the crankcase with the proper grade and quantity of engine oil. Fill and bleed the cooling system.

22. Connect the battery. Operate the engine until normal operating temperature has been reached and check for leaks.

## CAMSHAFT

The camshaft and related parts are shown in Fig. 27.

## REMOVAL

1. Drain the cooling system. Disconnect the upper and lower radiator hoses at the radiator. If equipped with automatic transmission, disconnect the oil cooler lines at the radiator. If equipped with air conditioning, remove the condenser.

2. Remove the cylinder front cover, fuel pump and the timing chain following the procedure under the Cylinder Front Cover and Timing Chain Removal.

3. Remove the intake manifold following the procedure under Intake Manifold Removal.

4. Remove the valve rocker arm

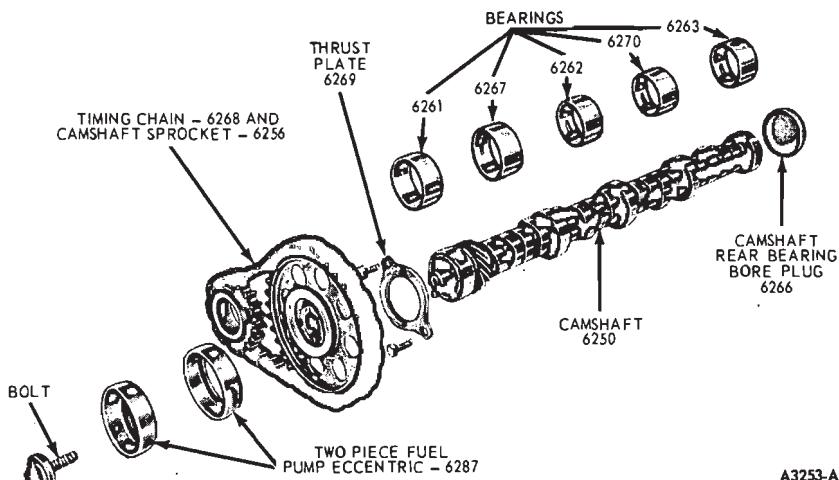


FIG. 27—Camshaft and Related Parts

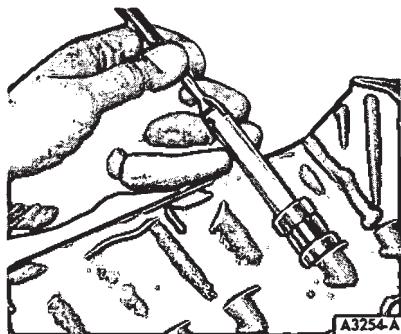


FIG. 28—Removing Valve Lifter

covers. Loosen the valve rocker arm fulcrum bolts and rotate the rocker arms to the side.

5. Remove the valve push rods and identify them so that they can be installed in their original positions.

6. Using a magnet, remove the valve lifters and place them in a rack so that they can be installed in their original bores (Fig. 28).

If the valve lifters are stuck in their bores by excessive varnish, etc., it may be necessary to use a plier-type tool (T52T-6500-DJD or 6500-D) or a claw type tool to remove the lifters. Rotate the lifter back and forth to loosen it from the gum or varnish that may have formed at the lifter.

7. Remove the camshaft thrust plate. Carefully remove the camshaft by pulling toward the front of the engine. Use caution to avoid damaging the camshaft bearings.

## INSTALLATION

Camshaft lobes are to be coated with Lubriplate or equivalent and the journals lubricated with heavy engine

oil MS before installation.

1. Oil the camshaft journals and apply Lubriplate to the lobes. Carefully slide the camshaft through the bearings. Install the camshaft thrust plate onto the cylinder block. Check camshaft end play as shown in Part 21-01, Section 1.

2. Install the valve lifters in the bores from which they were removed.

3. Install the timing chain, fuel pump cylinder front cover and related parts following steps 1 thru 13 under Cylinder Front Cover and Timing Chain Installation.

4. Adjust the drive belts to specifications.

5. Install the push rods in their original positions.

6. With No. 1 piston at TDC at the end of the compression stroke, POSITION A in Fig. 7, apply Lubriplate or equivalent to the valve stem tips. Lubricate the rocker arms and fulcrum seats with heavy engine oil MS. Install the rocker arms and perform a valve clearance check on the following valves:

No. 1 Intake No. 1 Exhaust

No. 4 Intake No. 3 Exhaust

No. 8 Intake No. 7 Exhaust

Position the crankshaft in POSITION B shown in Fig. 7 and install the push rods, apply Lubriplate or equivalent to the valve stem tips, install the rocker arms and perform a valve stem clearance check on the following valves:

No. 3 Intake No. 2 Exhaust

No. 7 Intake No. 6 Exhaust

Position the crankshaft in POSITION C shown in Fig. 7 and install the push rods, apply Lubriplate to the valve stem tips, install the rocker arms and perform a valve stem clear-

ance check on the following valves:

No. 2 Intake No. 4 Exhaust

No. 5 Intake No. 5 Exhaust

No. 6 Intake No. 8 Exhaust

7. Clean the valve rocker arm covers and the cylinder head gasket surfaces. Apply oil-resistant sealer to one side of new cover gaskets. Lay the cemented side of the gaskets in place in the covers.

8. Position the covers on the cylinder heads. Make sure the gasket seats evenly all around the head. Install the bolts. The cover is tightened in two steps. Torque the bolts to specifications. Two minutes later, torque the bolts to the same specifications.

9. Install the intake manifold, distributor and related parts by following procedures under Intake Manifold Installation.

10. Connect the accelerator cable and retracting spring. Install the vacuum lines that were disconnected from the intake manifold during removal.

11. Clean and install the crankcase ventilation system.

12. Install the distributor cap. Position the spark plug wires in the harness brackets on the valve rocker arm covers and connect the wires to the plugs. Connect the high tension lead at the coil.

13. If equipped with air conditioning, install the condenser.

14. Place the radiator shroud over the fan. Install the radiator and connect the hoses. If equipped with automatic transmission, connect the oil cooler lines at the radiator. On a Mustang or Cougar, install the radiator shroud attaching bolts.

15. Raise the vehicle. Remove the oil pan and install new gaskets and seals following procedures under Oil Pan Removal and Installation.

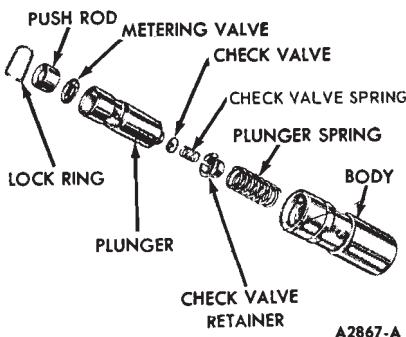
Lower the vehicle. On a Fairlane or Montego install the fan shroud attaching bolts.

16. Fill and bleed the cooling system. Fill the crankcase with the proper grade and quantity of engine oil.

17. Start the engine and check and adjust the ignition timing. Connect the distributor vacuum lines.

18. Operate the engine at fast idle and check all hose connections and gaskets for leaks. When the engine temperature has stabilized adjust the engine idle speed and idle fuel mixture.

19. Adjust the transmission throttle linkage. Install the air cleaner and intake duct assembly.



**FIG. 29—Type I Hydraulic Valve Lifter Assembly**

#### CAMSHAFT REAR BEARING BORE PLUG

##### REMOVAL

1. On a vehicle with a manual-shift transmission, remove the transmission, clutch pressure plate and disc following the procedures in Group 16.

On a vehicle with an automatic transmission, remove the transmission and converter housing following the procedure in Group 17.

2. Remove the flywheel attaching bolts and remove the flywheel. Remove the engine rear cover plate.

3. Remove the core plug as detailed in Part 21-01, Section 2.

##### INSTALLATION

1. Using tool T70P-6011-A, install the core plug as outlined in Part 21-01, Section 2.

2. Coat the flywheel attaching bolts with oil-resistant sealer. Position the engine rear cover plate on the cylinder block dowels. Position the flywheel on the crankshaft flange. Install and torque the attaching bolts in sequence across from each other to specifications.

On a vehicle with a manual-shift transmission, install the clutch pressure plate, disc and the transmission following the procedures in Group 16.

On a vehicle with an automatic transmission, install the transmission and converter housing following the procedure in Group 17.

#### VALVE LIFTER

Before replacing a hydraulic valve lifter for noisy operation, be sure the noise is not caused by improperly adjusted valve lash or by worn rocker arms or push rods.

#### REMOVAL

1. Remove the intake manifold and related parts by following procedures under Intake Manifold Removal.

2. Remove the crankcase ventilation regulator valve from the valve rocker arm cover.

3. Remove the valve rocker arm covers. Loosen the valve rocker arm fulcrum bolts and rotate the rocker arms to the side.

4. Remove the valve push rods and identify them so that they can be installed in their original positions.

5. Using a magnet, remove the valve lifters and place them in a rack so that they can be installed in their original bores (Fig. 28).

If the valve lifters cannot be removed from their bores due to excessive varnish, etc., it may be necessary to use a plier-type tool (T52T-6500-DJD or 6500-D) or a claw type tool to remove the lifters. Rotate the lifter back and forth to loosen it from the gum or varnish that may have formed at the lifter.

#### INSTALLATION

Tappets or lifters and bores are to be lubricated with heavy engine oil MS before installation.

1. Clean and install the valve lifters in the bores from which they were removed. If a new lifter(s) is being installed, check the new lifter(s) for a free fit in the bore in which it is to be installed. Lubricate the lifter(s) and bore(s) with heavy engine oil MS before inserting it in the bore.

2. Install the push rods in their original position. Apply Lubriplate or equivalent to the valve stem tips.

3. Position the No. 1 piston on TDC at the end of the compression stroke, POSITION A in Fig. 7. Lubricate with heavy engine oil MS and install the rocker arm, fulcrum seat and bolt on the following valves:

No. 1 Intake No. 1 Exhaust  
No. 4 Intake No. 3 Exhaust  
No. 8 Intake No. 7 Exhaust

Position the crankshaft in POSITION B, Fig. 7. Lubricate and install the rocker arm, fulcrum seat and bolt on the following valves:

No. 3 Intake No. 2 Exhaust  
No. 7 Intake No. 6 Exhaust

Position the crankshaft in POSITION C, Fig. 7. Lubricate and install the rocker arm, fulcrum seat and bolt on the following valves:

No. 2 Intake No. 4 Exhaust  
No. 5 Intake No. 5 Exhaust  
No. 6 Intake No. 8 Exhaust

Be sure that the fulcrum seat base is inserted in its slot on the cylinder head before tightening the attaching bolt.

Tighten the fulcrum bolts to specification. Check the valve clearance following the procedures under Valve Clearance—Checking Procedure.

4. Install the valve rocker arm covers. Install the crankcase ventilation regulator valve in the valve rocker arm cover.

5. Install the intake manifold and related parts by following procedures under Intake Manifold Installation.

#### VALVE LIFTER DISASSEMBLY

The internal parts of each hydraulic valve lifter assembly are matched sets. Do not intermix the parts. Keep the assemblies intact until they are to be cleaned.

The disassembly and assembly procedures for Types I and II valve lifters are different. Valve lifters should always be tested after assembly; refer to the test procedures covered in Part 21-01, Section 1.

##### TYPE I

###### Disassembly

Disassemble and assemble each lifter separately. Identify the lifter assemblies so they can be installed in their original bores.

1. Grasp the lock ring with needle nose pliers to release it from the groove. It may be necessary to depress the plunger to fully release lock ring.

2. Remove the push rod cup, metering valve (disc), plunger and spring.

3. Remove the plunger assembly, the check valve and the check valve retainer and plunger spring. Carefully remove the plunger spring, the check valve retainer and, the check valve disc from the plunger.

###### Assembly

Type I hydraulic lifter assembly is shown in Fig. 29.

1. Place the plunger upside down on a clean work bench.

2. Place the check valve (disc or ball check) in position over the oil hole on the bottom of the plunger. Set the check valve spring on top of the check valve (disc or ball check).

3. Position the check valve retainer over the check valve and spring and push the retainer down into place on

the plunger.

4. Place the plunger spring, and then the plunger (open end up) into the lifter body.

5. Position the metering valve (disc) in the plunger, and then place the push rod cup in the plunger.

6. Depress the plunger, and position the closed end of the lock ring in the groove of the lifter body. With the plunger still depressed, position the open ends of the lock ring in the groove. Release the plunger, and then depress it again to fully seat the lock ring.

7. Use the hydraulic valve lifter leakdown tester (Part 21-01) to fill the lifters with test fluid.

## TYPE II

### Disassembly

Each valve lifter is a matched assembly. If parts of one lifter are intermixed with those of another, improper valve operation may result. Disassemble and assemble each lifter separately. Keep the lifter assemblies in proper sequence so they can be installed in their original bores.

1. Grasp the lock ring with needle nose pliers to release it from the groove. It may be necessary to depress the plunger to fully release lock ring.

2. Remove the push rod cup, metering valve disc, and the upper metering valve. **Do not bend the metering valve or the valve tensioning finger.**

3. Remove the plunger assembly, the check valve and the check valve retainer and plunger spring. Carefully remove the plunger spring, the check

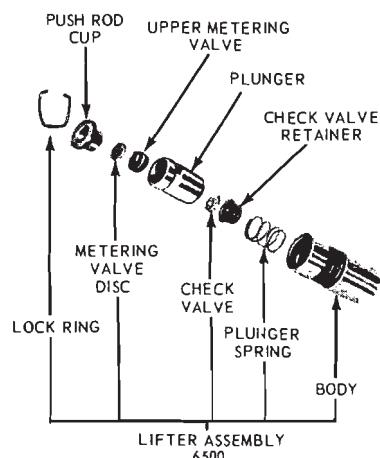


FIG. 30—Type II Hydraulic Valve Lifter Assembly

A 2505-A

valve retainer and the check valve disc from the plunger.

### Assembly

Type II hydraulic lifter assembly is shown in Fig. 30.

1. Place the plunger on a clean work surface (table or bench) in an inverted position and center the check valve disc on it. Carefully slide the check valve over the disc and down until it bottoms. A slight turning motion will help this. Use every precaution not to distort it in anyway, or to bend the preformed fingers. With a slight turning motion slide the plunger spring over the metering valve and down until it seats.

2. Leaving the assembly in the inverted position, slide the lifter body down over the spring until it slightly compresses the spring.

3. Position the combined assembly right side up on the work surface (table or bench).

4. Position the upper metering valve in the plunger taking care not to tilt it to either side, and not to damage or bend the valve tensioning finger. Place the metering valve disc over the metering valve and install the push rod cup. Depress the cup and install the lock ring.

5. Use the hydraulic valve lifter leakdown tester (Part 21-01) to fill the lifters with test fluid.

### CRANKSHAFT REAR OIL SEAL REPLACEMENT

Replacement of a crankshaft rear oil seal because of oil leakage requires replacement of both the upper and lower seals. Refer to Crankshaft Rear Oil Seal Replacement in Part 21-01 for replacement procedures.

### MAIN BEARING

The main bearing inserts are selective fit. Refer to procedures under Fitting Main and Connecting Rod Bearings in Part 21-01.

### REMOVAL

1. Drain the crankcase. Remove the oil level dipstick. Remove the oil pan and related parts.

2. Remove the oil pump and inlet tube assembly.

3. Replace one bearing at a time, leaving the other bearings securely fastened. Remove the main bearing cap to which new bearings are to be installed.

4. Insert the upper bearing removal tool (tool 6331) in the oil hole in the crankshaft.

5. Rotate the crankshaft in the direction of the engine rotation to force the bearing out of the block.

6. If the rear main bearing is being replaced, remove and discard the rear oil seal from the bearing cap.

Loosen all main bearing bolts, thereby lowering the crankshaft slightly but not to exceed 1/32 inch. Remove the block half of the rear oil seal. Use a seal removal tool or install a small metal screw in one end of the seal, and pull on the screw to remove the seal. Be careful not to burr the crankshaft seal rubbing surface.

### INSTALLATION

1. If the rear main bearing is being replaced, clean the rear oil seal groove in the block with a brush and solvent.

Carefully install the upper seal (split lip type) into its groove with the undercut side of the seal toward the FRONT of the engine (Fig. 31) by rotating it on the seal journal of the crankshaft until approximately 3/8 inch protrudes below the parting surface.

**Be sure no rubber has been shaved from the outside diameter of the seal by the bottom edge of the groove.**

Tighten the bolts on main bearings 1, 2, 3, and 4, thereby raising the crankshaft to its original position. Torque the bolts to specifications.

2. Clean the crankshaft journals. Inspect the journals and thrust faces (thrust bearing) for nicks, burrs or bearing pick-up that would cause premature bearing wear.

3. To install the upper main bearing, place the plain end of the bearing over the shaft on the locking tang side of the block and partially install the bearing so that tool 6331 can be inserted in the oil hole in the crankshaft. With tool 6331 positioned in the oil hole in the crankshaft, rotate the crankshaft in the opposite direction of engine rotation until the bearing seats itself. Remove the tool.

4. Replace the cap bearing.

5. Select fit the bearing for proper clearance following procedures under Fitting Main and Connecting Rod Bearings in Part 21-01.

6. If the bearing is being replaced on journal number 1, 2 or 4, apply a light coat of engine oil to the journal and bearings and install the bearing cap. Tighten the cap bolts to specifications.

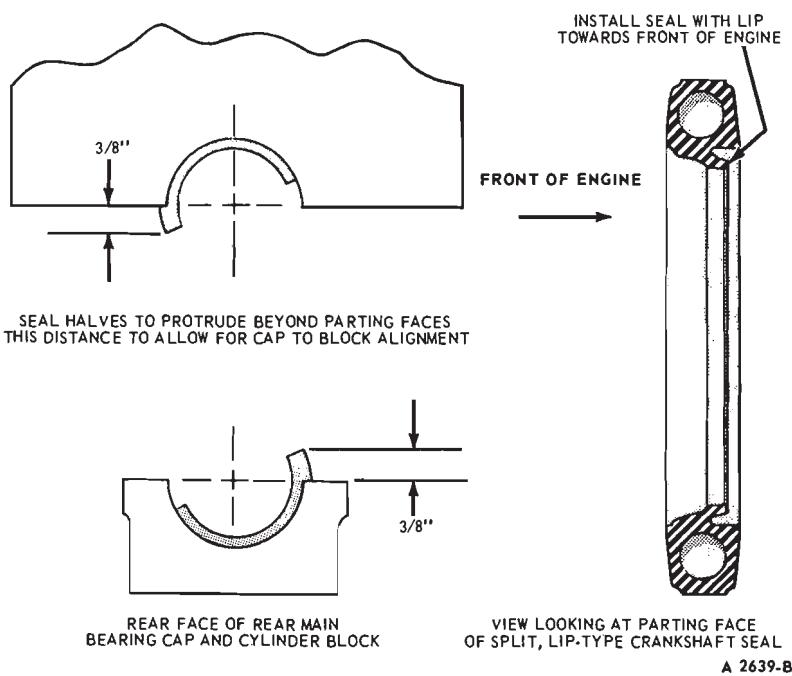


FIG. 31—Installing Crankshaft Rear Oil Seal

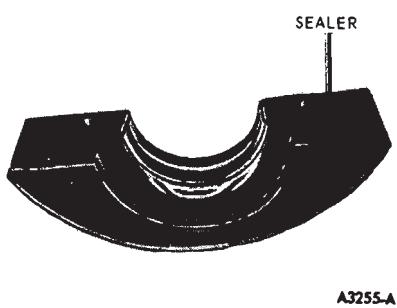


FIG. 32—Sealer Application to Rear Main Bearing Cap

7. If the rear main bearing is being replaced, clean the oil seal groove with a brush and solvent.

8. Install the lower seal in the rear main bearing cap with undercut side of seal toward the FRONT of the engine (Fig. 31), allow the seal to protrude approximately 3/8 inch above the parting surface to mate with the upper seal when the cap is installed.

9. Apply a thin coating of oil-resistant sealer to the rear main bearing cap at the rear of the top mating surface (Fig. 32). Do not apply sealer to the area forward of the oil slinger groove. Lubricate the journal with engine oil and install the rear main bearing cap with the rear surface flush or slightly forward of the rear of the cylinder block. Tighten the cap bolts to specifications.

10. If the thrust bearing cap (No. 3 main bearing) has been removed, install it as follows:

Lubricate the journal with engine oil and install the thrust bearing cap with the bolts finger-tight. Pry the crankshaft forward against the thrust surface of the upper half of the bearing (Fig. 47). Hold the crankshaft cap to the rear. This will align the thrust surfaces of both halves of the bearing. Retain the forward pressure on the crankshaft. Torque the cap bolts to specifications.

11. Clean the oil pump inlet tube screen. Prime by filling the inlet opening with oil and rotate the pump shaft until oil emerges from the outlet opening. Install the oil pump and the inlet tube assembly.

12. Position the oil pan gaskets on the oil pan. Position the oil pan front seal on the cylinder front cover. Position the oil pan rear seal on the rear main bearing cap. Install the oil pan and related parts. Install the oil level dipstick.

13. Fill the crankcase. Start the engine and check for oil pressure. Operate the engine at fast idle and check for oil leaks.

### CONNECTING ROD BEARINGS

The connecting rod bearings are selective fit. Refer to procedures under Fitting Main and Connecting Rod Bearings in Part 21-01.

### REMOVAL

1. Drain the crankcase. Remove the oil level dipstick. Remove the oil pan and related parts.

2. Remove the oil pump and inlet tube assembly.

3. Turn the crankshaft until the connecting rod to which new bearings are to be fitted is down. Remove the connecting rod cap. Remove the bearing inserts from the rod and cap.

### INSTALLATION

1. Be sure the bearing inserts and the bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause a failure.

2. Clean the crankshaft journal.

3. Install the bearing inserts in the connecting rod and cap with the tangs fitting in the slots provided.

4. Pull the connecting rod assembly down firmly on the crankshaft journal.

5. Select fit the bearing following procedures under Fitting Main and Connecting Rod Bearings in Part 21-01.

6. After the bearing has been fitted, clean and apply a light coat of engine oil to the journal and bearings. Install the connecting rod cap. Torque the nuts to specifications.

7. Clean the oil pump inlet tube screen. Prime by filling the inlet opening with oil and rotate the pump shaft until oil emerges from the outlet opening. Install the oil pump and the inlet tube assembly.

8. Position the oil pan gaskets on the oil pan. Position the oil pan front seal on the cylinder front cover. Position the oil pan rear seal on the rear main bearing cap. Install the oil pan and related parts. Install the oil level dipstick.

9. Fill the crankcase. Start the engine and check for oil pressure. Operate the engine at fast idle and check for oil leaks.

### PISTONS AND CONNECTING RODS

#### REMOVAL

1. Drain the cooling system and the crankcase. Remove the intake manifold, cylinder heads, oil pan and oil pump, following the procedures in this section.

2. Remove any ridges and/or deposits from the upper end of the cylinder bores as follows:

Turn the crankshaft until the piston to be removed is at the bottom of its travel and place a cloth on the piston head to collect the cuttings. Remove any ridge and/or deposits from the upper end of the cylinder bores. Remove the cylinder ridge with a ridge cutter. Follow the instructions furnished by the tool manufacturers. **Never cut into the ring travel area in excess of 1/32 inch when removing ridges.**

3. Make sure all connecting rod caps are marked so that they can be installed in their original positions.

4. Turn the crankshaft until the connecting rod being removed is down.

5. Remove the connecting rod nuts and cap.

6. Push the connecting rod and piston assembly out the top of the cylinder with the handle end of a hammer. **Avoid damage to the crankshaft journal or the cylinder wall when removing the piston and rod.**

7. Remove the bearing inserts from the connecting rod and cap.

8. Install the cap on the connecting rod from which it was removed.

## INSTALLATION

1. If new piston rings are to be installed, remove the cylinder wall glaze. Follow the instructions of the tool manufacturer.

2. Oil the piston rings, pistons and cylinder walls with light engine oil. Be sure to install the pistons in the same cylinders from which they were removed or to which they were fitted. The connecting rod and bearing caps are numbered from 1 to 4 in the right bank and from 5 to 8 in the left bank, beginning at the front of the engine. The numbers on the connecting rod and bearing cap must be on the same side when installed in the cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and the connecting rod should be numbered to correspond with the new cylinder number.

3. Make sure the ring gaps are properly spaced around the circumference of the piston (Fig. 33).

4. Install a piston ring compressor on the piston and push the piston in with a hammer handle until it is slightly below the top of the cylinder (Fig. 34). Be sure to guide the connecting rods to avoid damaging the crankshaft journals. **Install the piston with the arrow on the piston head**

## TOWARD THE FRONT OF THE ENGINE.

5. Check the clearance of each bearing following the procedure under Fitting Main and Connecting Rod Bearings in Part 21-01.

6. After the bearings have been fitted, apply a light coat of engine oil to the journals and bearings.

7. Turn the crankshaft throw to the bottom of its stroke. Push the piston all the way down until the connecting rod bearing seats on the crankshaft journal.

8. Install the connecting rod cap. Torque the nuts to specifications.

9. After the piston and connecting rod assemblies have been installed, check the side clearance between the connection rods on each crankshaft journal (Fig. 35).

10. Disassemble, clean, and assemble the oil pump. Clean the oil pump inlet tube screen and the oil pan and block gasket surfaces.

11. Prime the oil pump by filling either the inlet port or outlet port with engine oil and rotating the pump shaft to distribute the oil within the housing. Install the oil pump and the oil pan.

12. Install the cylinder heads following procedures under Cylinder Head Installation.

13. Install the intake manifold following procedures under Intake Manifold Installation.

14. Fill and bleed the cooling system. Fill the crankcase with the proper grade and quantity of engine oil.

15. Start the engine and check and adjust the ignition timing. Connect the distributor vacuum hoses at the distributor.

16. Operate the engine at fast idle until it reaches normal operating temperature and check for oil and coolant leaks. When the engine temperature has stabilized adjust the engine idle speed and idle fuel mixture.

17. Install the air cleaner and intake duct assembly.

## DISASSEMBLY

1. Remove the bearing inserts from the connecting rod and cap.

2. Mark the pistons and pins to assure assembly with the same rod and installation in the same cylinders from which they were removed.

3. Remove the piston rings. Using an Arbor Press and the tool shown in Fig. 36, press the piston pin from the piston and connecting rod.

## ASSEMBLY

The piston, connecting rod and related parts are shown in Fig. 37. Check the fit of a new piston in the cylinder bore before assembling the piston and piston pin to the connecting rod.

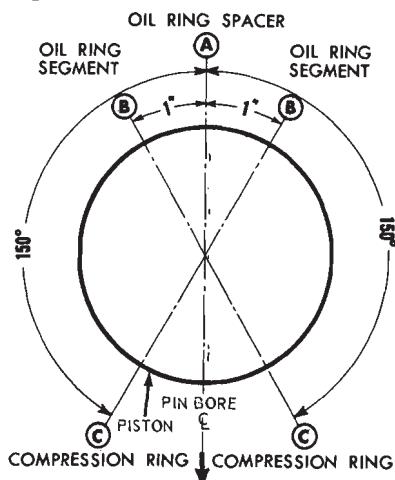


FIG. 33—Piston Ring Spacing

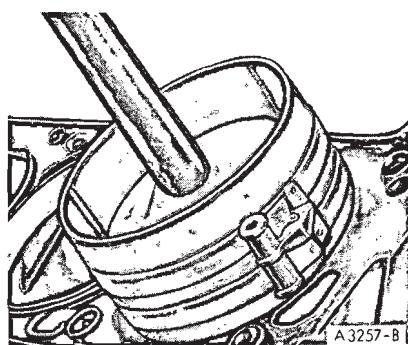


FIG. 34—Installing Piston

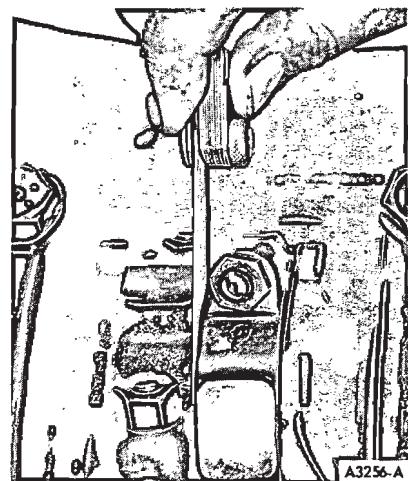
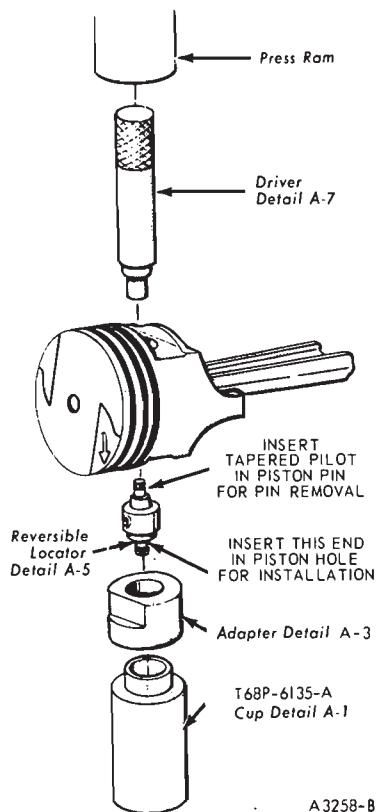
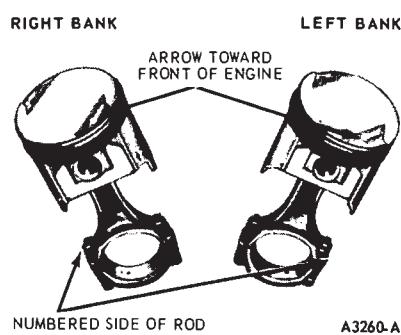


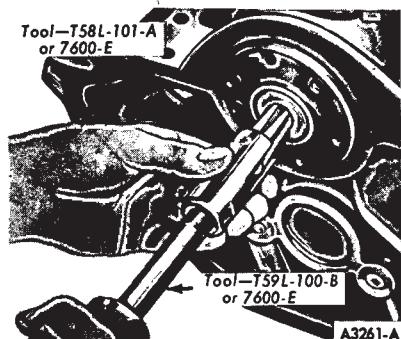
FIG. 35—Checking Connecting Rod Side Clearance



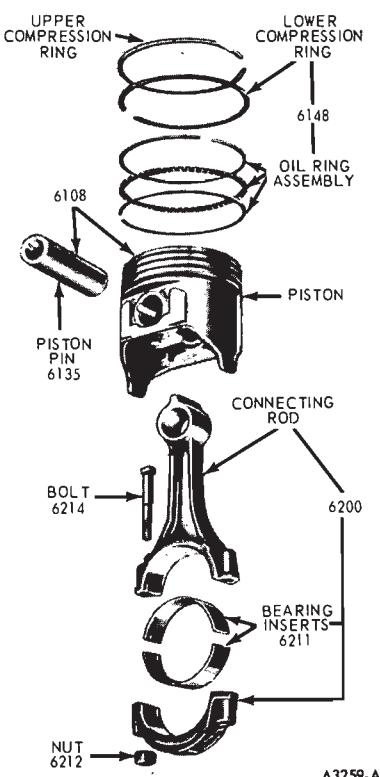
**FIG. 36—Removing or Installing Piston Pin**



**FIG. 38—Correct Piston and Rod Positions**



**FIG. 39—Removing Clutch Pilot Bushing**



**FIG. 37—Piston, Connecting Rod and Related Parts**

The gauge should slide freely around the entire ring circumference without binding. Any wear that occurs will form a step at the inner portion of the lower land. If the lower lands have high steps, the piston should be replaced.

5. Be sure the bearing inserts and the bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause a failure. Install the bearing inserts in the connecting rod and cap with the tangs fitting in the slots provided.

#### FLYWHEEL

##### REMOVAL

- On a vehicle with a manual-shift transmission, remove the transmission, clutch pressure plate and disc following the procedures in Group 16.

On a vehicle with automatic transmission, remove the transmission and converter housing following the procedure in Group 17.

- To check flywheel face runout or replace flywheel ring gear for manual-shift transmissions, refer to Part 21-01, Section 2.

- Remove the flywheel attaching bolts and remove the flywheel.

#### INSTALLATION

- Coat the threads of the flywheel attaching bolts with oil-resistant sealer. Position the flywheel on the crankshaft flange. Install and torque the bolts in sequence across from each other to specifications.

- On a vehicle with a manual-shift transmission, check the flywheel runout, following the procedure in Part 21-01, Section 1 and install the clutch pressure plate, disc and the transmission following the procedures in Group 16.

On a vehicle with an automatic transmission, check the flywheel runout, following the procedure in Part 21-01, Section 1 and install the transmission and converter housing following the procedure in Group 17.

#### CLUTCH PILOT BUSHING

##### REMOVAL

- Remove the transmission, clutch pressure plate and disc, following the procedures in Group 16.

- Remove the pilot bushing as shown in Fig. 39.

The piston pin bore of a connecting rod and the diameter of the piston pin must be within specifications. Refer to Section 5.

1. Apply a light coat of engine oil to all parts. Assemble the piston to the connecting rod with the cylinder number side of the connecting rod and the arrow on the piston positioned as shown in Fig. 38. On replacement connecting rods, install the large-chamfered side of the connecting rod bearing bore towards the crankshaft cheek; facing towards front of engine on right bank rods, and facing towards rear of engine on left bank rods.

2. Start the piston pin in the piston and connecting rod (this may require a very light tap with a mallet). Using an Arbor Press and the tool shown in Fig. 36, press the piston pin through the piston and connecting rod until the pin is centered in the piston.

3. Check the end gap of all piston rings (Part 21-01). It must be within specifications. Follow the instructions contained on the piston ring package and install the piston rings.

4. Check the ring side clearance of the compression rings with a feeler gauge inserted between the ring and its lower land (Part 21-01, Section 2).

## INSTALLATION

- Coat the pilot bushing bore in the crankshaft with a small quantity of wheel bearing lubricant. Avoid using too much lubricant as it may be thrown onto the clutch disc when the clutch revolves.
- Install the pilot service bearing as shown in Fig. 40.
- Install the clutch pressure plate, disc and the transmission, following the procedures in Group 16.

## OIL FILTER

### CARTRIDGE-TYPE OIL FILTER

The oil filter assembly is shown in Fig. 41.

#### Removal

Place a drip pan under the filter. Unscrew the filter from the adapter fitting and clean the adapter recess.

#### Installation

- Coat the gasket on a new filter with oil. Place the new filter in position on the adapter fitting. Hand tighten the filter until the gasket contacts the adapter face, and then advance it  $1/2$  turn.

- Operate the engine at fast idle, and check for oil leaks. If oil leaks are evident, perform the necessary repairs to correct leakage. Check the oil level and fill the crankcase if necessary.

### ELEMENT-TYPE OIL FILTER

The oil filter assembly is shown in Fig. 42.

#### Removal

- Place a drip pan under the filter. Loosen the filter center bolt, and then remove the filter assembly and gasket.

- Remove the filter element, neoprene gasket, spring and seat. Remove the center bolt from the filter cover and the fiber gasket from the bolt. Discard the filter element and all gaskets.

#### Installation

- Wash all parts in solvent. Make sure all the openings in the center bolt are clean.

- Install a new filter element in the filter cover following the instructions furnished with the new element.

- Clean the oil filter cover mounting surface on the adapter. Position a new gasket in the adapter recess.

- Place the filter assembly in position, and thread the center bolt into the adapter finger-tight. Rotate the filter slightly, in each direction, to make sure the gasket is seated evenly.

- Torque the center bolt to specifications. Do not over-tighten the center bolt.

- Add oil to the crankcase if necessary. Operate the engine at fast idle, and check for leaks.

- If oil leaks are evident, perform the necessary repairs to correct the leakage.

## OIL PAN

### REMOVAL

#### Mustang and Cougar

- Remove the oil level dipstick.
- Raise the vehicle.
- Drain the crankcase.
- Disconnect the starter cable and remove the starter.
- Remove the bolts retaining the sway bar to the chassis.
- Remove the two bolts retaining the number two crossmember to the chassis (Under the engine).
- Remove the oil pan attaching bolts.
- Turn the crankshaft for maximum clearance and remove the oil pan.

#### Fairlane and Montego

- Remove the oil level dipstick.
- Remove the fan shroud attaching bolts and position the fan shroud over the fan.
- Raise the vehicle.
- Drain the crankcase.
- Disconnect the starter cable and remove the starter.
- Remove the sway bar attaching bolts from the chassis and lower the sway bar for clearance.
- Remove the engine front support through bolts.
- Raise the engine and place wood blocks between the engine supports and chassis brackets.
- Remove the oil pan attaching bolts.
- If equipped with an automatic transmission, position the oil cooler lines out of the way.
- Remove the oil pan.

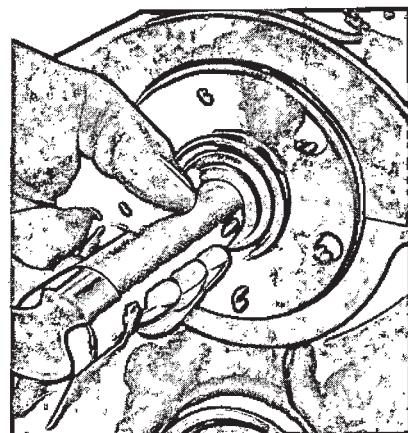
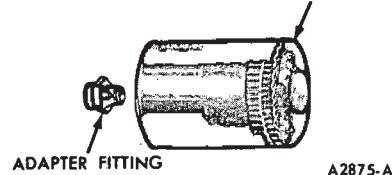


FIG. 40—Installing Clutch Pilot Bushing

A3262-A

FILTER ELEMENT



A2875-A

FIG. 41—Cartridge-Type Oil Filter

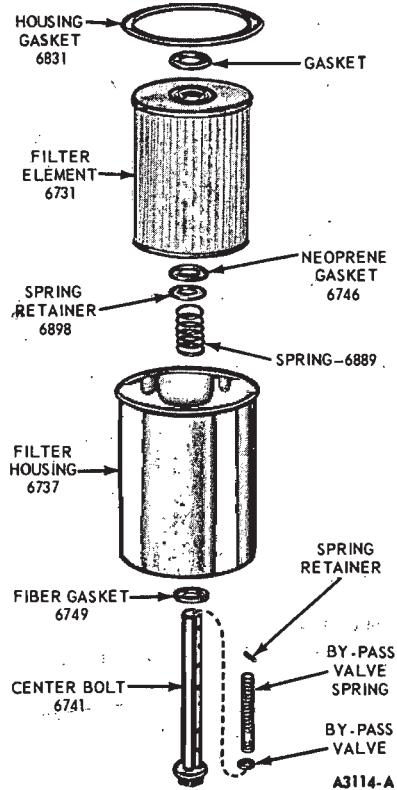


FIG. 42—Element-Type Oil Filter

A3114-A

## INSTALLATION

### Mustang and Cougar

1. Clean the gasket surfaces of the block and oil pan. The oil pan has a two-piece gasket. Coat the block surface and the oil pan gasket with sealer. Position the oil pan gaskets on the cylinder block (Fig. 43).

2. Position the oil pan front seal on the cylinder front cover. Be sure the tabs on the seal are over the oil pan gasket.

3. Position the oil pan rear seal on the rear main bearing cap (Fig. 43). Be sure the tabs on the seal are over the oil pan gasket.

4. Hold the oil pan in place against the block and install a bolt, finger-tight, on each side of the oil pan. Install the remaining bolts. Tighten the bolts from the center outward in each direction to specifications.

5. Install the number two crossmember and torque the bolts to specification.

6. Install the sway bar to the chassis. Tighten the nuts to specification.

7. Install the starter and connect the starter cable.

8. Lower the vehicle.

9. Install the oil level dipstick. Fill the crankcase with the proper grade and quantity of engine oil. Start the engine and check for oil leaks.

### Fairlane and Montego

1. Clean the gasket surfaces of the block and oil pan. The oil pan has a two-piece gasket.

2. Clean the oil pump pick-up tube and screen.

3. Coat the block surface and the oil pan gasket with sealer. Position the oil pan gaskets on the cylinder block (Fig. 43).

4. Position the oil pan front seal on the cylinder front cover. Be sure the tabs on the seal are over the oil pan gasket.

5. Position the oil pan rear seal on the rear main bearing cap (Fig. 43). Be sure the tabs on the seal are over the oil pan gasket.

6. Position the oil pan against the block and install a bolt, finger-tight, on each side of the block. Install the remaining bolts. Tighten the bolts from the center outward in each direction to specifications.

7. Raise the engine and remove the wood blocks from between the engine supports and chassis brackets. Lower the engine and install the engine sup-

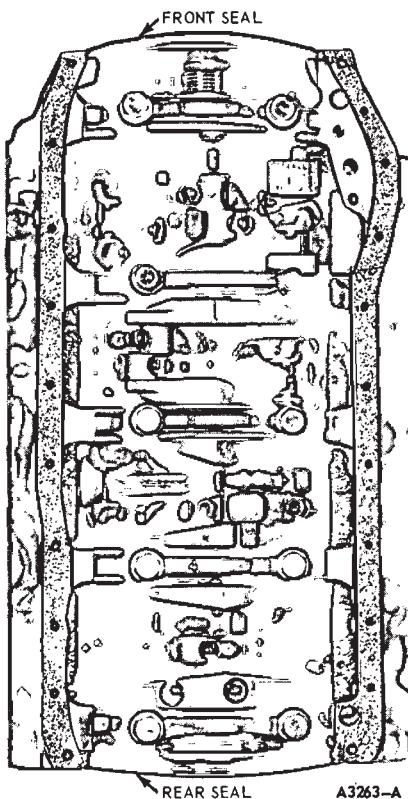


FIG. 43—Oil Pan Gasket and Seals Installed

port through bolts. Tighten the bolts to specifications.

8. Install the sway bar to chassis attaching bolts.

9. Install the starter and connect the starter cable.

10. Lower the vehicle.

11. Install the fan shroud attaching bolts.

12. Install the oil level dipstick. Fill the crankcase with the proper grade and quantity of engine oil. Start the engine and operate at idle speed until it reaches normal operating temperature. Check for oil leaks.

## OIL PUMP

### REMOVAL

1. Remove the oil pan and related parts as outlined under Oil Pan Removal.

2. Remove the oil pump attaching bolts and remove the oil pump with pick up tube and screen, gasket and intermediate drive shaft.

### INSTALLATION

1. Clean and install the oil pump inlet tube and screen assembly (Fig. 44).

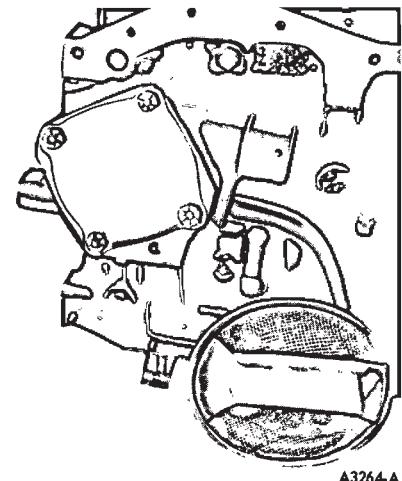


FIG. 44—Oil Pump and Inlet Tube Installed

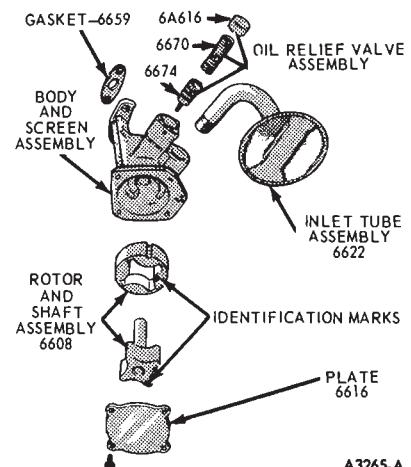


FIG. 45—Oil Pump Assembly

2. Prime the oil pump by filling either the inlet or outlet port with engine oil. Rotate the pump shaft to distribute the oil within the pump body.

3. Position the intermediate drive shaft into the distributor socket. With the shaft firmly seated in the distributor socket, the stop on the shaft should touch the roof of the crankcase. Remove the shaft and position the stop as necessary.

4. Position a new gasket on the pump housing. With the stop properly positioned, insert the intermediate drive shaft into the oil pump. Install the pump and shaft as an assembly. **Do not attempt to force the pump into position if it will not seat readily. The drive shaft hex may be misaligned with the distributor shaft. To align, rotate the intermediate drive shaft into a new position.** Tighten the oil pump attaching screws to specification.

cations.

Be sure the oil pick up screen is parallel with the oil pan mounting surface.

5. Install the oil pan and related parts as outlined under Oil Pan Installation.

#### DISASSEMBLY

1. Remove the oil inlet tube from the oil pump.

2. Remove the cover attaching screws, then remove the cover. Remove the inner rotor and shaft assembly.

bly, then remove the outer race.

3. Insert a self-threading sheet metal screw of the proper diameter into the oil pressure relief valve chamber cap and pull the cap out of the chamber. Remove the spring and plunger.

#### ASSEMBLY

The oil pump assembly is shown in Fig. 45.

1. Oil all parts thoroughly.

2. Install the oil pressure relief valve plunger, spring and a new cap.

3. Install the outer race and the inner rotor and shaft assembly. Be sure the dimple (identification mark) on the outer race is facing outward and on same side as identification mark on rotor. The race rotor and shaft and the outer race are serviced as an assembly. One part should not be replaced without replacing the other. Install the cover and tighten the cover attaching screws to specifications.

4. Install the oil inlet tube and screen assembly on the oil pump.

### 3 ENGINE REMOVAL AND INSTALLATION

#### REMOVAL

1. Disconnect the battery, drain the cooling system and remove the hood.

2. Remove the air cleaner and intake duct assembly.

3. Disconnect the upper radiator hose at the engine and the lower hose at the radiator. On vehicles equipped with automatic transmission, disconnect the oil cooler lines at the radiator.

4. Remove the fan shroud attaching bolts and position the shroud over the fan. Remove the radiator and shroud.

5. Remove the fan and spacer.

6. On vehicles equipped with air-conditioning, loosen the idler pulley and remove the drive belt.

7. Loosen the alternator and remove the drive belt.

8. On vehicles with power steering, loosen and remove the power steering pump drive belt.

9. Remove the water pump pulley.

10. On vehicles with power steering, remove the power steering pump brackets and position the pump out of the way in an upright position to prevent fluid loss.

11. On vehicles equipped with air conditioning, isolate and remove the compressor as outlined in Group 34.

12. Remove the alternator and bracket. Position the alternator out of the way. Disconnect the alternator ground wire from the cylinder block.

13. Disconnect the heater hoses at the block and water pump.

14. Remove the ground wires from the cylinder block and right cylinder head.

15. Disconnect the fuel line at the

fuel pump. Plug the fuel tank line. Disconnect the vacuum lines at the rear of the intake manifold.

16. Disconnect the accelerator cable or linkage at the carburetor and intake manifold. Disconnect transmission downshift linkage, if so equipped.

17. Disconnect the engine wire loom at the ignition coil, water temperature sending unit and oil pressure sending unit. Remove the wire loom from the hold down clips.

18. Raise the vehicle and secure with safety stands.

19. Disconnect the muffler inlet pipe at the exhaust manifolds.

20. Disconnect the starter cable and remove the starter.

21. Remove the engine front support through bolts and the starter cable clamp at the right front engine support.

22. If equipped with automatic transmission, remove the converter inspection cover and disconnect the flywheel from the converter. Remove the downshift rod.

Remove the four lower converter housing-to-engine block bolts and the adaptor plate-to-converter housing bolt.

On vehicles equipped with a manual transmission, remove the clutch linkage from the cylinder block and remove the four lower bell housing-to-engine block bolts.

23. Lower the vehicle.

24. Remove the two upper converter or bell housing bolts.

25. Attach engine lifting sling, Tool No. T53L-300-A, and hoist to lifting brackets at exhaust manifolds.

26. Position a jack under the transmission.

27. Raise the engine slightly and carefully pull it from the transmission. Carefully lift the engine out of the engine compartment so that the rear cover plate is not bent or components damaged. Install the engine on a work stand.

#### INSTALLATION

1. Attach engine lifting sling, Tool No. T53L-300-A, and hoist to lifting brackets at exhaust manifolds. Remove engine from work stand.

2. Lower the engine carefully into the engine compartment. Make sure the exhaust manifolds are properly aligned with the muffler inlet pipes.

On a vehicle with an automatic transmission, start the converter pilot into the crankshaft.

On a vehicle with a manual-shift transmission, start the transmission main drive gear into the clutch disc. It may be necessary to adjust the position of the transmission in relation to the engine if the input shaft will not enter the clutch disc. If the engine hangs up after the shaft enters, turn the crankshaft slowly (transmission in gear) until the shaft splines mesh with the clutch disc splines.

3. Install the bell housing or converter housing upper bolts, making sure that the dowels in the cylinder block engage the flywheel housing. Remove the jack from under the transmission.

4. Remove the lifting sling.

5. On automatic transmission equipped vehicles, position the downshift rod on the transmission and engine.

6. Raise the vehicle and secure

with safety stands.

7. On a vehicle with an automatic transmission, position the transmission linkage bracket and install the remaining converter housing bolts. Install the adapter plate-to-converter housing bolt. Install the converter-to-flywheel nuts and install the inspection cover. Connect the downshift rod on the transmission:

On a vehicle with a manual transmission, install the lower bellhousing bolts and connect the clutch linkage to the engine block.

8. Install the starter and connect the cable.

9. Connect the muffler inlet pipes at the exhaust manifolds.

10. Install the engine front support through bolts and install the starter cable clamp at the right front engine support.

11. Lower the vehicle.

12. Install the ground wire at the

right cylinder head. Install the engine wire loom and connect it to the ignition coil, water temperature sending unit and oil pressure sending unit.

13. Install the accelerator linkage and connect the downshift rod, if so equipped.

14. Connect the vacuum lines at the rear of the intake manifold. Connect the fuel tank line at the fuel pump.

15. Connect the ground wire at the right front of cylinder block. Install the heater hoses at the water pump and cylinder block.

16. Install the alternator and bracket. Connect the alternator ground wire to the cylinder block.

17. On a vehicle with air conditioning, install the air conditioning compressor and brackets as outlined in Group 34.

18. On a vehicle with power steering, install the power steering pump

and brackets.

19. Install the water pump pulley, fan and spacer. Install the drive belts on their respective pulleys and adjust the belt tension to specifications.

20. Position the fan shroud over the fan. Install the radiator and connect the upper and lower radiator hoses. Install the fan shroud attaching bolts.

21. Fill and bleed the cooling system. Fill the crankcase with the proper grade and quantity of oil. Adjust the transmission downshift linkage, if so equipped. Connect the battery.

22. Operate the engine at fast idle until it reaches normal operating temperature and check all gaskets and hose connections for leaks. Adjust ignition timing and idle speed.

23. Install the air cleaner and intake duct. Install and adjust the hood.

## 4 MAJOR REPAIR OPERATIONS

When installing nuts or bolts that must be torqued (refer to Section 5 for torque specifications), oil the threads with light weight engine oil. **Do not oil threads that require oil-resistant or water-resistant sealer.**

To perform the operations in this section, it will be necessary to remove the engine from the vehicle and install it on a work stand.

Refer to Part 21-01, Section 3 for cleaning and inspection procedures.

### CRANKSHAFT

The crankshaft and related parts are shown in Fig. 46.

#### REMOVAL

1. Disconnect the spark plug wires at the spark plugs and remove the wires from the ignition harness brackets on the valve rocker arm covers. Disconnect the coil-to-distributor cap and spark plug wire assembly. Remove the spark plugs to allow easy rotation of the crankshaft.

2. Disconnect the fuel pump outlet line at the pump. Remove the fuel pump from the cylinder block. Remove the alternator and mounting brackets.

3. Remove the crankshaft pulley from the crankshaft vibration damp-

er. Remove the cap screw and washer from the end of the crankshaft. Install the puller on the crankshaft vibration damper (Fig. 20) and remove the damper.

4. Remove the timing pointer. Remove the water pump and cylinder front cover as an assembly. Discard the gasket and remove the crankshaft front oil slinger.

5. Check the timing chain deflection (Refer to Part 21-01, Section 1). Remove the camshaft sprocket cap screw, washer and two piece fuel pump eccentric. Slide both sprockets and the timing chain forward and remove them as an assembly (Fig. 25).

6. Invert the engine on the work stand. Remove the clutch pressure plate and disc (manual-shift transmission). Remove the flywheel and engine rear cover plate. Remove the oil pan and gasket. Remove the oil pump.

7. Make sure all bearing caps (main and connecting rod) are marked so that they can be installed in their original locations. Turn the crankshaft until the connecting rod from which the cap is being removed is down, and remove the bearing cap. Push the connecting rod and piston assembly up into the cylinder. Repeat this procedure until all the connecting rod bearing caps are removed.

8. Remove the main bearing caps.

9. Carefully lift the crankshaft out of the block so that the thrust bearing surfaces are not damaged. Handle the crankshaft with care to avoid possible fracture or damage to the finished surfaces.

To refinish journals, dress minor imperfections, etc., refer to Part 21-01, Section 2.

### INSTALLATION

1. Remove the rear journal oil seal from the block and rear main bearing cap.

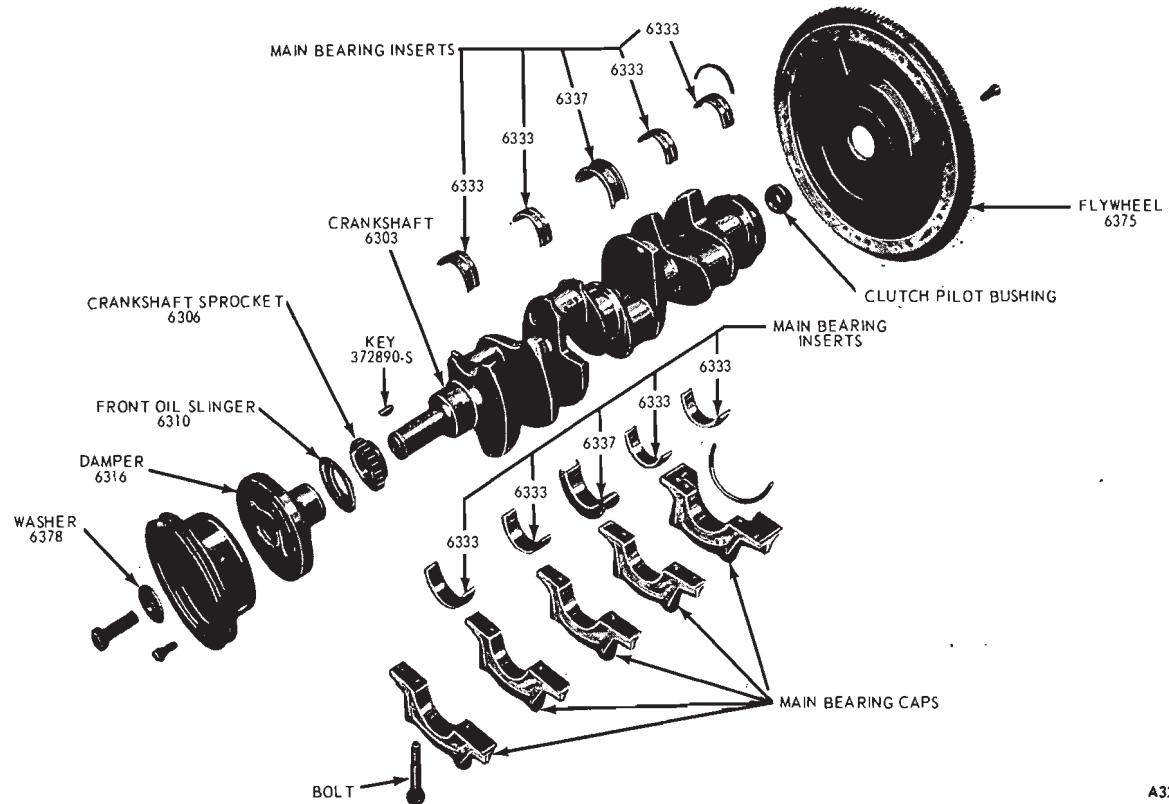
2. Remove the main bearing inserts from the block and bearing caps.

3. Clean the rear journal oil seal groove and the mating surfaces of the block and rear main bearing cap.

4. Remove the connecting rod bearing inserts from the connecting rods and caps.

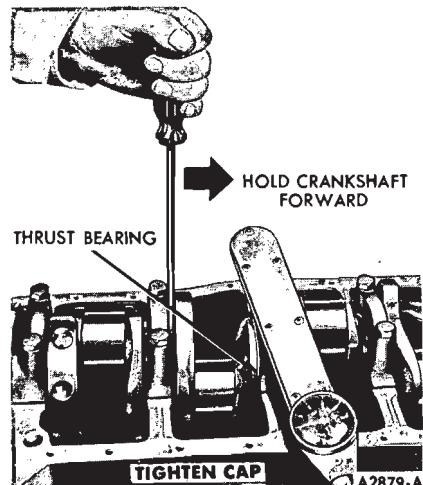
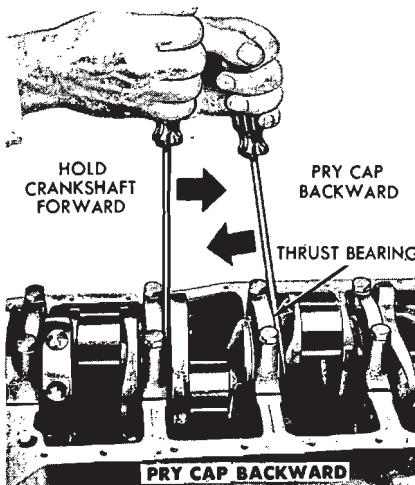
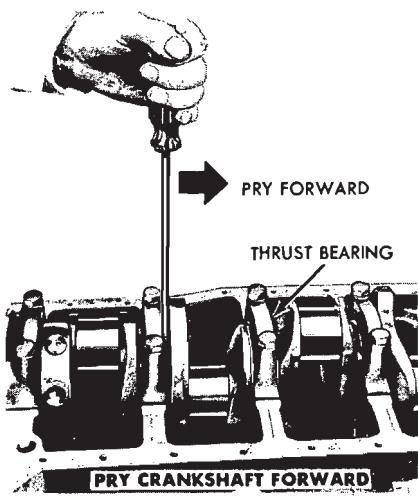
5. If the crankshaft main bearing journals have been refinished to a definite undersize, install the correct undersize bearings. Be sure the bearing inserts and bearing bores are clean. Foreign material under the inserts will distort the bearing and cause a failure.

6. Place the upper main bearing inserts in position in the bores with the tang fitting in the slot provided.



A3266-A

FIG. 46—Crankshaft and Related Parts



A2879-A

FIG. 47—Aligning Thrust Bearing

7. Install the lower main bearing inserts in the bearing caps.

8. Dip the lip seal halves in clean engine oil. Install the lip seals in the bearing cap and block with the undercut side of the seal toward the FRONT of the engine as shown in Fig. 31.

9. Carefully lower the crankshaft into place. Be careful not to damage the bearing surface.

10. Check the clearance of each main bearing following the procedure

under Fitting Main and Connecting Rod Bearings in Part 21-01.

11. After the bearings have been fitted, apply a thin coating of oil-resistant sealer to the rear main bearing cap at the rear of the top mating surface (Fig. 32). Do not apply sealer to the area forward of the oil slinger groove.

12. Apply heavy engine oil MS to the journals and bearings.

13. Install the rear main bearing cap with the rear surface flush or

slightly ahead of the rear of the cylinder block. Install all bearing caps, except the thrust bearing cap (No. 3 bearing). Be sure that the main bearing caps are installed in their original locations. Torque the bearing cap bolts to specifications.

14. Install the thrust bearing cap with the bolts finger-tight.

15. Pry the crankshaft forward against the thrust surface of the upper half of the bearing (Fig. 47).

16. Hold the crankshaft forward

and pry the thrust bearing cap to the rear. This will align the thrust surfaces of both halves of the bearing.

17. Retain the forward pressure on the crankshaft. Tighten the cap bolts to specifications.

18. Force the crankshaft toward the rear of the engine.

19. Check the crankshaft end play (Refer to Part 21-01, Section 1).

20. Install the timing chain and sprockets, cylinder front cover and fuel pump, following steps 1 thru 8 under Cylinder Front Cover and Timing Chain Installation.

21. Install the engine rear cover plate onto the alignment dowels at the rear of the cylinder block.

22. Coat the threads of the flywheel attaching bolts with oil-resistant sealer. Position the flywheel on the crankshaft flange. Install and tighten the bolts to specifications.

On a flywheel for a manual-shift transmission, use tool 6392-N to locate the clutch disc. Install the pressure plate. Tighten the attaching bolts.

23. Install new bearing inserts in the connecting rods and caps. Check the clearance of each bearing following the procedures under Fitting Main and Connecting Rod Bearings in Part 21-01.

24. After the connecting rod bearings have been fitted, apply a light coat of engine oil to the journals and bearings.

25. Turn the crankshaft throw to the bottom of its stroke. Push the piston all the way down until the rod bearing seats on the crankshaft journal.

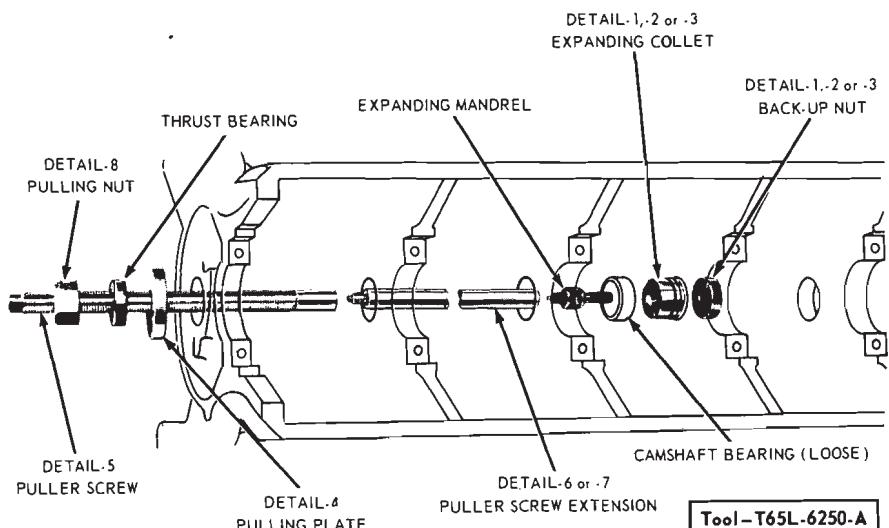
26. Install the connecting rod cap. Torque the nuts to specifications.

27. After the piston and connecting rod assemblies have been installed, check the side clearance between the connecting rods on each connecting rod crankshaft journal (Fig. 35).

28. Clean the oil pan, oil pump and oil pump screen. Prime the oil pump by filling either the inlet or outlet port with engine oil and rotating the pump shaft to distribute oil within the housing. Install the oil pump and oil pan by following the procedures under Oil Pan and Oil Pump Installation.

29. Install the front oil seal, vibration damper and crankshaft pulley, following steps 10 thru 12 under Cylinder Front Cover and Timing Chain Installation.

30. Install the spark plugs, distributor cap and spark plug wires. Connect the spark plug wires and high



A2813-A

**FIG. 48—Camshaft Bearing Replacement**

tension lead.

31. Install the engine in the vehicle.

#### CAMSHAFT BEARING

Camshaft bearings are available pre-finished to size for standard and 0.015-inch undersize journal diameters. The bearings are not interchangeable from one bore to another.

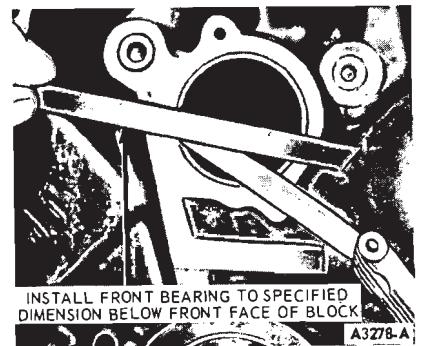
#### REMOVAL

1. Remove the camshaft, flywheel and crankshaft, following the appropriate procedures in Section 2 or Section 4. Push the pistons to the top of the cylinders.

2. Remove the camshaft rear bearing bore plug. Remove the camshaft bearings (Fig. 48).

3. Select the proper size expanding collet and back-up nut and assemble on the expanding mandrel. With the expanding collet collapsed, install the collet assembly in the camshaft bearing, and tighten the back-up nut on the expanding mandrel until the collet fits the camshaft bearing.

4. Assemble the puller screw and extension (if necessary) as shown and install on the expanding mandrel. Wrap a cloth around the threads of the puller screw to protect the front bearing or journal. Tighten the pulling nut against the thrust bearing and pulling plate to remove the camshaft bearing. Be sure to hold a wrench on the end of the puller screw to prevent



**FIG. 49—Camshaft Front Bearing Measurement**

it from turning.

5. Repeat the procedure for each bearing. To remove the front bearing, install the puller screw from the rear of the cylinder block.

#### INSTALLATION

1. Position the new bearings at the bearing bores with the oil holes aligned, and press them in place with the tool shown in Fig. 48. Be sure to center the pulling plate and puller screw to avoid damage to the bearing. Failure to use the correct expanding collet can cause severe bearing damage. Be sure the front bearing is installed the specified distance below the front face of the cylinder block (Fig. 49).

2. Install the core plug as detailed in Part 21-01, Section 2.

3. Install the camshaft, crankshaft, flywheel and related parts, following the appropriate procedures in Section 2 or Section 4, except do not check connecting rod and main bearing clearances as a part of Camshaft Bearing Replacement. Install the engine in the vehicle.

## CYLINDER ASSEMBLY REPLACEMENT

### DISASSEMBLY

Follow steps 1 thru 17, 19, 20 and 24 thru 27 under Engine Disassembly. Remove 4 cylinder head dowels from the cylinder block. Remove the cylinder block drain plugs and remove the cylinder assembly from the work stand.

### ASSEMBLY

Clean the gasket and seal surfaces of all parts and assemblies.

Install the replacement cylinder assembly on a work stand. Install the cylinder block drain plugs and cylinder head dowels. Transfer all parts removed from the old cylinder assembly, following the procedures in steps 19, 20, 24 thru 27 and 29 thru 64 under Engine Assembly. Check all assembly clearances and correct as necessary.

## CYLINDER BLOCK REPLACEMENT

Before replacing a cylinder block, determine if it is repairable, and make the necessary repairs following the procedures in Part 21-01, Section 2.

### DISASSEMBLY

Follow steps 1 thru 17, 19 and 20 thru 32 under Engine Disassembly. Remove the 4 cylinder head dowels and the cylinder block drain plugs from the cylinder block. Remove the cylinder block from the work stand.

### ASSEMBLY

Install the replacement cylinder block on the work stand. Install the cylinder block drain plugs and cylinder head dowels. Transfer the parts removed from the old cylinder block to the new cylinder block by following steps 5 thru 64 under Engine Assembly. Check all assembly clearances and correct as necessary.

## ENGINE DISASSEMBLY AND ASSEMBLY

### DISASSEMBLY

1. Install the engine on the work stand.
2. Remove the distributor cap, coil high tension wire and spark plug wires as an assembly.
3. Disconnect the primary wire at the coil and remove the coil.
4. Remove the alternator and brackets from the water pump and cylinder head.
5. Remove the crankcase emission valve from the right rocker arm cover.
6. Disconnect the carburetor to fuel pump line and remove the line. Remove the carburetor.
7. Disconnect the vacuum lines at the distributor and control valve. Remove the distributor hold down bolt and the distributor.

8. Remove the intake manifold attaching bolts. Raise the intake manifold and carefully remove it from the engine. Discard the gasket and seals.
9. Remove the rocker arm covers.
10. Remove the rocker arm fulcrum bolts and remove the fulcrum seats and rocker arms. Place the rocker arms and fulcrum seats in order of removal so that they can be installed in their original location.

11. Remove the valve push rods in sequence and put them in a rack or holder so that they can be installed in their original position.
12. Using a magnet, remove the valve lifters and place them in a rack so that they can be installed in their original bores (Fig. 28).

If the valve lifters are stuck in their bores by excessive varnish, etc., it may be necessary to use a plier-type tool (T52T-6500-DJD or 6500-D) or a claw-type tool to remove the lifters. Rotate the lifter back and forth to loosen it from the gum or varnish that may have formed at the lifter.

The internal parts of each hydraulic valve lifter assembly are matched sets. Do not intermix the parts. Keep the assemblies intact until they are to be cleaned.

13. Remove the exhaust manifolds and the spark plugs.
14. Remove the cylinder head bolts and lift the cylinder heads off the block. Discard the cylinder head gaskets.
15. Remove the crankshaft pulley from the crankshaft vibration damper. Remove the cap screw and washer from the end of the crankshaft. In-

stall the puller on the crankshaft vibration damper (Fig. 20) and remove the vibration damper.

16. Remove the timing pointer.
17. Remove the cylinder front cover attaching screws. Remove the cylinder front cover and water pump as an assembly. Discard the gasket and remove the crankshaft front oil slinger.
18. Remove the water pump from the front cover.
19. Remove the thermostat housing and thermostat from the block. Remove the oil pressure and temperature sending units from the block.
20. Remove the fuel pump.
21. Check the timing chain deflection (refer to Part 21-01, Section 1). Remove the camshaft sprocket cap screw, washer and two piece fuel pump eccentric. Slide both sprockets and the timing chain forward, and remove them as an assembly (Fig. 25).
22. Remove the camshaft thrust plate. Carefully remove the camshaft by pulling it toward the front of the engine. Use caution to avoid damaging the journals and lobes.
23. Remove any ridge and/or carbon deposits from the upper end of the cylinder bores. Move the piston to the bottom of its travel and place a cloth on the piston head to collect the cuttings. Remove the cylinder ridge with a ridge cutter. Follow the instructions furnished by the tool manufacturer. Never cut into the ring travel area in excess of 1/32 inch when removing ridges. After the ridge has been removed, remove the cutter from the cylinder bore.
24. On a flywheel for a manual-shift transmission, remove the clutch pressure plate and disc.
25. Remove the flywheel and rear cover plate. Remove the clutch pilot bushing (Fig. 39).
26. Invert the engine. Remove the oil pan and discard the gaskets and seals.
27. Remove the oil pump and inlet tube as an assembly. Remove the intermediate drive shaft. Discard the oil pump gasket.
28. Make sure all connecting rods and caps are marked so that they can be installed in their original locations. Turn the crankshaft until the connecting rod being removed is down. Remove the rod cap.
29. Push the connecting rod and piston assembly out of the top of the cylinder with the handle end of a hammer. Avoid damage to the connecting rod journal or the cylinder wall when removing the piston and

rod.

30. Remove the bearing inserts from the connecting rods and caps. Install the rod caps on the connecting rods from which they were removed.

31. Remove the main bearing caps.

32. Carefully lift the crankshaft out of the cylinder block so that the thrust bearing surfaces are not damaged. Handle the crankshaft with care to avoid possible fracture or damage to the finished surfaces.

33. Remove the rear journal oil seal from the block and rear bearing cap.

34. Remove the main bearing inserts from the block and bearing caps. Install the main bearing caps in their original positions.

35. Remove the camshaft rear bearing bore plug. Remove the camshaft bearings (Fig. 48).

## ASSEMBLY

If the cylinder block is to be replaced, transfer the cylinder head dowels, front cover and rear cover plate alignment dowels, dip stick tube, oil filter adapter, fuel pump retaining stud and drain plugs to the new cylinder block and start the assembly procedures with step number 5.

1. If the original cylinder block is used, remove the glaze from the cylinder bores by following the instructions in Part 21-01, Section 2.

2. Invert the engine on the work stand.

3. Position the new camshaft bearings at the bearing bores with the oil holes aligned, and press them in place with the tool shown in Fig. 49. Be sure the camshaft front bearing is installed the specified distance below the front face of the cylinder block.

4. Using tool T70P-6011-A, install the core plug as detailed in Part 21-01, Section 2.

5. Oil the camshaft journals and apply Lubriplate to all lobes, and then carefully slide it through the bearings. Install the camshaft thrust plate and check camshaft end play as shown in Part 21-01, Section 1.

6. If the crankshaft main bearing journals have been refinished to a definite undersize, install the correct undersize bearings. Be sure the bearing inserts and bearing bores are clean. Foreign material under the inserts will distort the bearing and cause a failure.

Place the upper main bearing inserts in position in the bore with the tank fitting in the slot provided.

7. Install the lower main bearing inserts in the bearing caps.

8. Dip the lip seal halves in clean engine oil. Install the lip seals in the bearing cap and block with the undercut side of the seal toward the FRONT of the engine as shown in Fig. 31.

9. Carefully lower the crankshaft into place. Be careful not to damage the bearing surfaces.

10. Check the clearance of each main bearing following the procedure under fitting main and connecting rod bearings in Part 21-01.

11. After the bearings have been fitted apply a thin coating of oil-resistant sealer to the rear main bearing cap at the rear of the top mating surface (Fig. 32). Do not apply sealer to the area forward of the oil slinger groove.

12. Apply heavy engine oil MS to the journals and bearings.

13. Install the rear main bearing cap with the rear surface flush or slightly ahead of the rear of the cylinder block. Install all bearing caps, except the thrust bearing cap (No. 3 bearing). Be sure that the main bearing caps are installed in their original positions. Tighten the bearing cap bolts to specifications.

14. Install the thrust bearing cap with the bolts finger-tight.

15. Pry the crankshaft forward and pry the thrust bearing cap to the rear (Fig. 47). This will align the thrust surfaces of both halves of the bearing.

16. Retain the forward pressure on the crankshaft. Tighten the cap bolts to specifications.

17. Check the crankshaft end play (Refer to Part 21-01, Section 1).

18. Install the clutch pilot service bearing (Fig. 40). Coat the threads of the flywheel attaching bolts with oil-resistant sealer. Position the rear cover plate on the block and the flywheel on the crankshaft flange. Install and tighten the bolts to specifications.

On a flywheel for a manual-shift transmission, use tool T58P-7563-A to locate the clutch disc. Install the pressure plate.

19. Turn the engine on the work stand so that the front end is up.

20. Position the sprockets and timing chain on the camshaft and crankshaft (Fig. 25). Be sure the timing marks on the sprockets are positioned as shown in Fig. 24.

21. Lubricate the timing chain and sprockets with engine oil.

22. Install the two piece fuel pump eccentric, washer and camshaft sprocket cap screw. Tighten the

sprocket cap screw to specifications. Install the crankshaft front oil slinger (Fig. 26).

23. Position a fuel pump gasket on the block and install the fuel pump. Tighten the fuel pump attaching screw and nut to specification.

24. Remove the front crankshaft seal from the cylinder front cover with the tool shown in Fig. 21. Clean the cylinder front cover water pump and the cylinder block gasket surfaces.

25. Coat the water pump gasket on both sides with sealer. Install the water pump and gasket onto the cylinder front cover.

26. Coat the cylinder front cover gasket on both sides with oil-resistant sealer. Install the cylinder front cover onto the alignment dowels. Install the timing pointer and front cover retaining screws.

27. Install the pistons and connecting rods by following steps 1 thru 9 under Piston and Connecting Rod Installation.

28. Invert the engine on the work stand. Position the intermediate drive shaft into the distributor socket. With the shaft firmly seated in the distributor socket, the stop on the shaft should touch the roof of the crankcase. Remove the shaft and position the stop as necessary.

29. With the stop properly positioned, insert the intermediate driveshaft into the oil pump.

30. Prime the oil pump by filling either the inlet or outlet port with engine oil. Rotate the pump shaft to distribute the oil within the pump body.

31. Position a new gasket on the pump housing and install the pump and shaft as an assembly. Tighten the oil pump attaching screws to specifications.

32. Clean the gasket surfaces of the block and oil pan. Coat the block surface and the oil pan gasket surface with sealer. Position new gaskets on the block and position a new seal on the cylinder front cover and rear main bearing cap. Make sure the tabs on the seal are over the oil pan gasket. Install the attaching screws and tighten them from the center outward to specifications (one screw secures the fuel line bracket).

33. Install the front crankshaft oil seal into the cylinder front cover with the tool shown in Fig. 22.

34. Lubricate the crankshaft with a white lead and oil mixture and apply Lubriplate to the oil seal rubbing surface of the vibration damper inner

hub to prevent damage to the oil seal.

35. Line up the crankshaft vibration damper keyway with the key on the crankshaft, and then install the vibration damper on the crankshaft (Fig. 23). Install the damper cap screw and washer, and tighten the screw to specifications. Install the crankshaft pulley.

36. Turn the engine on the work stand so that the top of the engine is up.

37. Clean the cylinder head and block gasket surfaces. Install the head gasket over the cylinder head dowels. **Do not apply sealer to the head gasket surfaces.**

38. Place the cylinder head on the engine. Coat the head bolt threads with water-resistant sealer, and then install the bolts.

39. The cylinder head bolt tightening procedure is performed in three progressive steps. Tighten the bolts in sequence (Fig. 13) to 50 ft-lbs, then to 60 ft-lbs and finally to specifications. When cylinder head bolts have been tightened following this procedure it is not necessary to retorque the bolts after extended operation. However, the bolts may be checked and retightened if desired.

40. Coat the cylinder head mating surfaces of the exhaust manifold with a light film of graphite grease.

41. Position the exhaust manifolds on the cylinder heads and install the attaching bolts and flat washers. Tighten the attaching bolts to specifications, working from the center to the ends.

42. Install the spark plugs.

43. Use the hydraulic valve lifter leakdown tester (Part 21-01) to fill the lifters with test fluid. Coat the outside of each valve lifter and lifter bore with heavy engine oil MS to provide initial lubrication. Place each lifter in the bore from which it was removed.

44. Clean the mating surfaces of the intake manifold, cylinder heads and cylinder block.

45. Position new seals on the cylinder block and press the seal locating extensions into the holes in the mating surface.

Apply non-hardening sealer at the four junction points of the seals and cylinder heads. Position the intake manifold gasket onto the block and cylinder heads with the alignment notches under the dowels on the cylinder heads. Be sure the holes in the gasket are aligned with the holes in the cylinder head.

46. Carefully lower the intake

manifold into position on the cylinder heads.

47. Be sure the holes in the manifold gaskets and manifold are in alignment. Install the intake manifold attaching bolts. Tighten the intake manifold bolts in three steps (Fig. 10).

Tighten all bolts in sequence to 8-10 ft-lb.

Tighten all bolts in sequence to 15-20 ft-lb.

Tighten all bolts in sequence to specifications.

**After completing the remaining assembly steps, operate the engine until it reaches normal operating temperature, then retorque the manifold bolts in sequence to specifications.**

48. Lubricate and install the push rods in their original positions. Apply Lubriplate or equivalent over the valve stem tips.

49. With the No. 1 piston at TDC on the end of the compression stroke, POSITION A in Fig. 7, install the rocker arm, fulcrum seat and bolt and perform a valve clearance check on the following valves:

- No. 1 Intake No. 1 Exhaust
- No. 4 Intake No. 3 Exhaust
- No. 8 Intake No. 7 Exhaust

Position the crankshaft in POSITION B, Fig. 7, and install the rocker arm, fulcrum seat and bolt and perform a valve clearance check on the following valves:

- No. 3 Intake No. 2 Exhaust
- No. 7 Intake No. 6 Exhaust

Position the crankshaft in POSITION C, Fig. 7, and install the rocker arm, fulcrum seat and bolt and perform a valve clearance check on the following valves:

- No. 2 Intake No. 4 Exhaust
- No. 5 Intake No. 5 Exhaust
- No. 6 Intake No. 8 Exhaust

**Be sure the fulcrum seat base is inserted in its slot on the cylinder head before tightening the fulcrum bolts.** Tighten the fulcrum bolts to specification. Check the valve clearance following the procedures under Valve Clearance Checking Procedure.

50. Rotate the crankshaft until the No. 1 piston is TDC at the end of the compression stroke, then position the distributor in the block with the rotor at the No. 1 firing position and the points just open. Install the hold down clamp.

51. Remove the water pump by-pass orifice plug (Fig. 50). Install a new water pump by-pass orifice plug with the tool shown in Fig. 51.

52. Coat a new thermostat housing gasket on both sides with sealer. In-

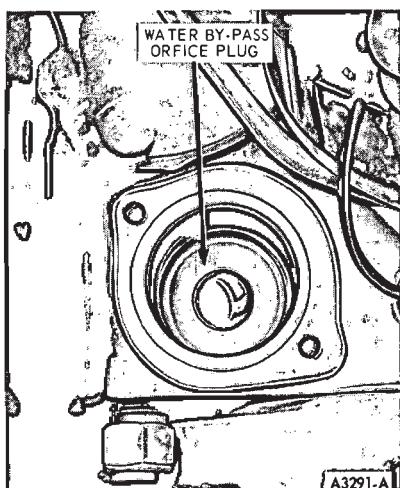


FIG. 50—Water Pump By-Pass Orifice Plug

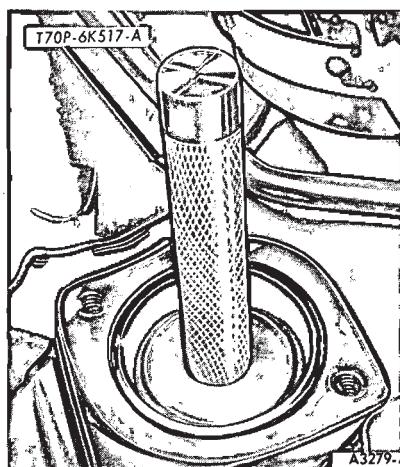


FIG. 51—Installing Water Pump By-Pass Orifice Plug

stall the thermostat housing, thermostat and gasket. Tighten the thermostat housing bolts to specification.

53. Coat the threads of the oil pressure sending unit and the temperature sending unit with electrical conductive sealer. Install the oil pressure and temperature sending units in the block.

54. Install the ignition coil. Position and install the alternator and mounting bracket.

55. Connect the vacuum lines following the schematic shown in Part 22-01.

56. Clean the valve rocker arm covers and the cylinder head gasket surface. Apply oil-resistant sealer to one side of new cover gaskets. Lay the cemented side of the gaskets in place in the covers.

57. Position the covers on the cylinder heads. Make sure the gasket

seats evenly all around the head. Install the bolts. The cover is tightened in two steps. Tighten the bolts to specifications. Two minutes later, tighten the bolts to the same specifications.

**58.** Install the carburetor and connect the fuel pump to carburetor fuel line.

**59.** Install the crankcase ventilation system.

**60.** Install the distributor cap. Position the spark plug wires in the

brackets on the valve rocker arm covers. Connect the spark plug wires and the coil wire.

**61.** Clean the oil filter gasket surface. Coat the gasket on the filter with oil. Place the filter in position on the adapter fitting. Hand tighten the filter until the gasket contacts the adapter face, then advance it 1/2 turn.

**62.** Install the engine in the vehicle. Fill and bleed the cooling system. Fill

the crankcase with the proper grade and quantity of engine oil.

**63.** Operate the engine and check for oil and coolant leaks. Check and adjust the ignition timing. Connect the distributor vacuum hose to the distributor. Retorque intake manifold bolts to specifications.

**64.** Adjust the engine idle speed, fuel mixture and anti-stall dashpot (if applicable). Adjust the transmission throttle linkage.

## 5 SPECIFICATIONS

### GENERAL SPECIFICATIONS

Engine	Compression Ratio	Bore and Stroke	Taxable Horsepower	Brake Horsepower	Gross Torque Ft.-Lbs
351-C-2V	9.5:1	4.00 x 3.50	51.2	250 @ 4600	355 @ 2600
351-C-4V	11.0:1	4.00 x 3.50	51.2	300 @ 5400	380 @ 3400

### GENERAL SPECIFICATIONS (Continued)

Engine	Compression Pressure PSI (Sea Level) @ Cranking Speed ①	Engine Idle Manifold Vacuum ②	Oil Pressure-Hot @ 2000 RPM	Firing Order	Belt Tension (Ft. Lbs.) ③
351-C	When checking compression, take the highest compression reading and compare it to the lowest reading. The lowest reading must be within 75% of the highest.	15	35-60	1-3-7-2-6-5-4-8	New 140 Used 110

① See Compression Pressure Limit Chart - Part 21-01  
 ② Minimum inches of Mercury @ specified engine RPM (sea level). This includes automatic transmission in neutral. Subtract 1 inch of Mercury for engines equipped with dual diaphragm distributors.  
 ③ All belts.

## PERFORMANCE SPECIFICATIONS

Engine	Curb Idle RPM ①②		Fast Idle RPM	③ Initial Ignition Timing BTDC	Dwell Angle at Idle Speed	Distributor Point Gap	Spark Plug Gap	Spark Plug No.
	④ With Solenoid Throttle Positioner	Without Solenoid Throttle Positioner						
351-C-2V	700/500 Manual Transmission 600/500 Automatic Transmission	600 Automatic Transmission	1500 Man. Tran. 1500 Auto. Tran.	6°	⑤	⑥	0.035	AF-42
351-C-4V	700/500 Manual Transmission 600/500 Automatic Transmission	600 Automatic Transmission	1250 Man. Tran. 1400 Auto. Tran.	6°	⑤	⑥	0.035	AF-32

① Higher idle speed with solenoid energized and lower idle speed with solenoid de-energized  
 ② With head lights on high beam  
 ③ A/C Off, if so equipped  
 ④ Distributor vacuum lines disconnected  
 ⑤ Dual diaphragm distributor with single points ..... 24°-29° dwell angle, 0.021 point gap  
 ⑥ Single diaphragm distributor with single points ..... 26°-31° dwell angle, 0.017 point gap

## ENGINE PERFORMANCE SPECIFICATIONS (Continued)

Engine	Anti-Stall Dashpot Clearance	Automatic Choke Setting	Accelerator Pump Setting			Idle Air Fuel Ratio	
			Pump Link	Lever Position			
				Man Trans	Auto Trans	Man Trans	Auto Trans
351-C-2V	1/8 Inch ( $\pm 1/64$ ) ⑦	Index-Manual Transmission I-Rich-Automatic Transmission	Inboard	#4	#3	12.90:1	11.40:1
351-C-4V	0.080 ⑧	Index	Pump Stem Height 0.425 $\pm$ 0.020			13.15:1	12.20:1

⑦ Solenoid equipped on models with manual transmission and or A/C

## CYLINDER HEAD

Engine	Combustion Chamber Volume	Valve Guide Bore Diameter (Standard Intake and Exhaust)	Valve Seat Width		Valve Seat Angle	Valve Seat Runout (Maximum)	Valve Arrangement (Front to Rear)	Gasket Surface Flatness ⑨
			Intake	Exhaust				
351-C-2V	74.7-77.7	0.3433-0.3443	0.060 0.080	0.070 0.090	45°	0.0015	Right I-E-I-E-I-E-I-E Left E-I-E-I-E-I-E-I-E	0.003 inch in Any 6 inches
351-C-4V	61.3-64.3							0.007 Overall

⑨ Head Gasket Surface Finish R.M.S. ..... 90-150.

## VALVE ROCKER ARMS, PUSH RODS AND TAPPETS

Engine	Rocker Arm Lift Ratio	Valve Push Rod (Maximum Runout)	Valve Tappet or Lifter		
			Standard Diameter	Clearance To Bore ①	Hydraulic Lifter Leakdown Rate
351-C	1.73:1	0.020	0.8740-0.8745	0.0007-0.0027	5-50 Seconds Maximum—Measured at 1/16 inch plunger travel
① Wear Limit—0.005					

## VALVE SPRINGS

Engine	Valve Spring Pressure Lbs @ Specified Length		Valve Spring Free Length Approximate	Valve Spring Assembled Height Pad to Retainer	Valve Spring Out-of-Square (Maximum)
	Pressure	Wear Limit			
351-C-2V	76-84 @ 1.820 199-221 @ 1.420	68 @ 1.820 179 @ 1.420	2.07	1 13/16-1 27/32	5/64 (0.078)
351-C-4V	85-95 @ 1.820 271-299 @ 1.320	79 @ 1.820 244 @ 1.320	2.05	1 13/16-1 27/32	

## VALVES

Engine	To Valve Guide Clearance ①		Valve Stem to Rocker Arm Clearance		Valve Head Diameter		Valve Face Angle
	Intake	Exhaust	Allowable	Desired	Intake	Exhaust	
351-C-2V					2.036-2.046	1.650-1.660	
351-C-4V	0.0010-0.0027	0.0015-0.0032	0.100-0.200	0.100-0.150	2.183-2.198	1.705-1.715	44°
① Wear Limit 0.0055							

## VALVES (Continued)

Engine	Valve Stem Diameter							
	Standard		0.003 Oversize		0.015 Oversize		0.030 Oversize	
	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust
351-C	0.3416-0.3423	0.3411-0.3418	0.3446-0.3453	0.3441-0.3448	0.3566-0.3573	0.3561-0.3568	0.3716-0.3723	0.3711-0.3718

## CAMSHAFT

Engine	Lobe Lift ①		Theoretical Valve Lift		Camshaft		Camshaft Journal to Bearing Clearance	
	Intake	Exhaust	Intake	Exhaust	End Play	Wear Limit	Clearance	Wear Limit
351-C-2V	0.235	0.235	0.407	0.407				
351-C-4V	0.247	0.247	0.427	0.427	0.0010-0.00055	0.009	0.001-0.003	0.006
① Maximum allowable lobe lift loss ..... 0.005								

## CAMSHAFT (Continued)

Item	Bearing	351-C	Item	Bearing	351-C
Camshaft Journal	(No 1)	2.1238-2.1248	Camshaft Bearings	(No 1)	2.1258-2.1268
	(No 2)	2.0655-2.0665		(No 2)	2.0675-2.0685
Diameter—	(No 3)	2.0505-2.0515	Inside Diameter	(No 3)	2.0525-2.0535
	(No 4)	2.0355-2.0365		(No 4)	2.0375-2.0385
Standard ①	(No 5)	2.0205-2.0215		(No 5)	2.0225-2.0235
Camshaft Bearing Location ②	(No 1)	0.003-0.005			
① Camshaft journal maximum runout ..... 0.008					
Camshaft journal maximum out-of-round ..... 0.001					
② Distance in inches that the front edge of the bearing is installed towards the rear from the front face of the cylinder block.					

## CAMSHAFT DRIVE MECHANISM

Crankshaft Sprocket Assembled Face Runout TIR Max.	Timing Chain Deflection (Maximum)
0.006	0.500

## CAMSHAFT VALVE TIMING

Engine	Intake Valve			Exhaust Valve	
	Opens	Closes		Opens	Closes
351-C-2V	0.004 inch @ 12° BTC	0.006 inch @ 66° ABC		0.004 inch @ 66° BBC	0.006 inch @ 20° ATC
351-C-4V	0.004 inch @ 14° BTC	0.006 inch @ 72° ABC		0.004 inch @ 70° BBC	0.006 inch @ 20° ATC

## CYLINDER BLOCK

Engine	Cylinder Bore Diameter ①	Cylinder Bore Diameter 0.003 OS	Tappet Bore Diameter	Main Bearing Bore Diameter	Cylinder Block Distributor Shaft Bearing Bore Diameter	Head Gasket Surface Flatness ②
351-C	4.0000-4.0024	4.0024-4.0036	0.8752-0.8767	2.9417-2.9429	0.5155-0.5171	0.003 inch in any 6 inches or 0.007 inch Overall
① Maximum out-of-round ..... 0.001				② Head gasket surface finish RMS ..... 90-150		
Wear Limit ..... 0.005						
Cylinder bore surface finish RMS ..... 15-35						

## CRANKSHAFT AND FLYWHEEL

Engine	Main Bearing Journal Diameter ①	Main Bearing Journal Runout-Maximum	Main Bearing Journal Thrust Face Runout	Main Bearing Journal Taper Max	Thrust Bearing Journal Length	Main Bearing Surface Finish RMS Maximum	
						Journal	Thrust Face
351-C	2.7484-2.7492	0.004	0.001	0.0003 Per Inch	1.124-1.126	12	20
① Connecting rod and main bearing journal out-of-round maximum 0.0004							

## CRANKSHAFT AND FLYWHEEL (Continued)

Engine	Connecting Rod Journal Diameter ①	Connecting Rod Bearing Journal Maximum Taper	Crankshaft Free End Play	Crankshaft To Rear Face Of Block Runout TIR Max	Flywheel Clutch Face Runout	Flywheel OD Runout Transmission	
						Standard	Automatic
351-C	2.3103-2.3111	0.0004 Per Inch	0.004-0.010	0.010	0.010	0.018	0.020
① Connecting rod and main bearing journal out-of-round maximum 0.004							

## CRANKSHAFT BEARINGS

Engine	Connecting Rod Bearings			Main Bearings			
	To Crankshaft Clearance		Wall Thickness-Standard ①	To Crankshaft Clearance		Wall Thickness-Standard ②	
	Desired	Allowable		Desired	Allowable	Standard	Automatic
351-C	0.001-0.0015	0.0008-0.0026	0.0620-0.0625	0.0005-0.0015	0.0013-0.0029	0.0957-0.0960	
① 0.002 U S Thickness ..... Add 0.0010 to Standard Thickness      ② 0.002 U S Thickness ..... Add 0.0010 to Standard Thickness							

## CONNECTING ROD

Engine	Piston Pin Bore Or Bushing ID	Connecting Rod Bearing Bore Diameter ①	Connecting Rod Length Center To Center	Connecting Rod Alignment Maximum Total Difference ②		Connecting Rod Assembly (Assembled To Camshaft)	
				Twist	Bend	Side Clearance	Wear Limit
351-C	0.9104-0.9112	2.4361-2.4369	5.7785-5.7815	0.012	0.004	0.010-0.020	0.023
① Connecting rod bearing bore maximum out-of-round and taper ..... 0.004							
② Pin bushing and crankshaft bearing bore must be parallel and in the same vertical plane within the specified total difference at ends of 8-inch long bar measured 4 inches on each side of rod.							

## PISTON

Engine	Diameter ①			Piston To Cylinder Bore Clearance	Piston Pin Bore Diameter	Ring Groove Width	
	Coded Rod	Coded Blue	0.003 Oversize				
351-C	3.9982-3.9988	3.9994-4.0000	4.0006-4.0012	0.0014-0.0022	0.9122-0.9125	Upper Compression Ring ... 0.080-0.081 Lower Compression Ring ... 0.080-0.081 Oil Ring ..... 0.1880-0.1870	
① Measured at the piston pin bore centerline at 90° to the pin bore.							

**PISTON PIN**

Engine	Length	Diameter		To Piston Clearance	To Connecting Rod Clearance
		Standard	0.001 Oversize		
351-C	3.010-3.040	0.9119-0.9124	0.9130-0.9133	0.0003-0.0005 ①	①
①Wear Limit 0.0008      ① Interference Fit					

**PISTON RINGS**

Engine	Ring Width		Side Clearance			Ring Gap Width		
	Compression Ring		Compression Ring ①		Oil Ring	Compression Ring		Oil Ring ②
	Top	Bottom	Top	Bottom		Top	Bottom	
351-C	0.077-0.078	0.077-0.078	0.002-0.004	0.002-0.004	Snug	0.010-0.020	0.010-0.020	0.015-0.069
①Wear Limit ..... 0.006      ① Steel Rail								

**OIL PUMP**

Engine	Rotor-Type Oil Pump Relief Valve Spring Tension Lbs @ Specified Length	Drive Shaft To Housing Bearing Clearance	Relief Valve Clearance	Rotor Assembly End Clearance	Outer Race To Housing (Radial Clearance)
351-C	23.6-24.6 @ 1.37	0.0015-0.0029	0.0015-0.0029	0.0011-0.0041	0.006-0.013

**APPROXIMATE OIL PAN CAPACITIES ①**

Engine	U.S. Measure	Imperial Measure
351-C	5 Quarts	4 Quarts

①Includes one quart with filter replacement

**TORQUE LIMITS-FT. LBS**

Item	Engine	Item	Engine
	351-C		351-C
Cylinder Head Bolts		Oil Filter to Block Cartridge Type	With grease on gasket surface, hand tighten until gasket contacts adapter face, then tighten 1/2 turn more.
Step 1	55	Element Type	20-25
Step 2	65	Cylinder Front Cover	12-15
Step 3	95-100	Water Pump Bolts	12-14
Oil Pan to Cylinder Block	9-11 (5/16 x 18) 7-9 (1/4 x 20)	Camshaft Sprocket to Camshaft	40-45
Intake Manifold Bolts	23-25 (5/16 Bolt) 28-32 (3/8 Bolt)	Camshaft Thrust Plate to Block	9-12
Exhaust Manifold Bolts	18-24	Vibration Damper to Crankshaft	70-90
Water Outlet Housing	12-15	Crankshaft Pulley to Vibration Damper UBS Bolts	25-35
Distributor Vacuum Control Valve	15-18	Place Bolts	35-45
Flywheel to Crankshaft	75-85	Connecting Rod Nuts	40-45
Main Bearing Cap Bolts	60-70	Valve Rocker Arm Cover	3-5
Oil Pan Drain Plug	15-20	Fuel Pump to Cylinder Block	12-15
Oil Pump to Cylinder Block	20-25	Rocker Arm Bolt to Cylinder Head	17-23
Oil Pump Cover Plate	9-12		
Oil Filter Adapter to Block	20-50		

## TORQUE LIMITS (Cont'd.)

Engine Support	Car Line	
Item	Fairlane, Montego	Mustang, Cougar
Engine Front Supports Insulator to Engine	35-60	
Insulator to Support Bracket	20-30	
Mounting Bracket to Frame	20-30	
Engine Rear Supports Insulator to Transmission	30-45	Man. Trans. 20-30 Auto. Trans. 30-45
Insulator to Crossmember	30-50	25-35
Crossmember to Frame	50-70	10-20

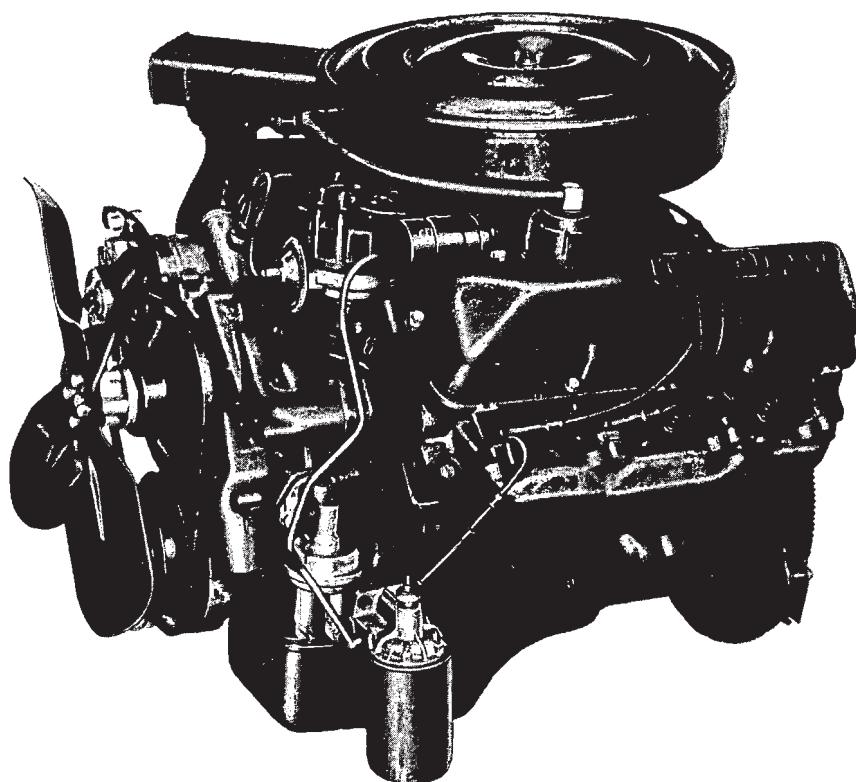
## TORQUE LIMITS FOR VARIOUS SIZE BOLTS

CAUTION: If any of the torque limits listed in this table disagree with any of those listed in the preceding tables, the limits listed in the preceding tables prevail.						
Size (Inches)	1/4-20	1/4-28	5/16-18	5/16-24	3/8-16	3/8-24
Torque (Ft-lbs)	6-9	6-9	12-15	15-18	23-28	30-35
Size (Inches)	7/16-14	7/16-20	1/2-13	1/2-20	9/16-18	5/8-18
Torque (Ft-lbs)	45-50	50-60	60-70	70-80	85-95	130-145

CA1054-A

# PART 21-06 390 and 428 V8 Engines

<b>MODEL APPLICATION—390—Ford, Mercury and Meteor 428—Cougar and Mustang —Ford and Mercury Police</b>			
<b>Component</b>	<b>Page</b>	<b>Component</b>	<b>Page</b>
<b>CAMSHAFT</b>		<b>MAIN AND CONNECTING ROD BEARINGS</b>	
Bearing Bore Plug .....	21-16	Connecting Rod Bearings .....	21-19
Bearing Removal and Installation .....	21-28	Main Bearings .....	21-18
Camshaft Removal and Installation .....	21-15		
<b>CLUTCH PILOT BUSHING</b>		<b>OIL FILTER</b>	
Installation .....	21-21	Installation .....	21-21
Removal .....	21-21	Removal .....	21-21
<b>CRANKSHAFT</b>		<b>OIL PAN</b>	
Installation .....	21-26	Installation .....	21-22
Removal .....	21-26	Removal .....	21-21
<b>CYLINDER ASSEMBLY (SHORT BLOCK)</b>		<b>OIL PUMP</b>	
Assembly .....	21-28	Assembly .....	21-23
Disassembly .....	21-28	Disassembly .....	21-23
<b>CYLINDER BLOCK</b>		Installation .....	21-22
Assembly .....	21-29	Removal .....	21-22
Disassembly .....	21-28		
<b>CYLINDER FRONT COVER AND TIMING CHAIN</b>		<b>PISTONS AND CONNECTING RODS</b>	
Installation .....	21-14	Assembly .....	21-20
Oil Seal .....	21-14	Disassembly .....	21-20
Removal .....	21-13	Installation .....	21-20
		Removal .....	21-19
<b>CYLINDER HEAD</b>		<b>SPECIFICATIONS</b>	21-32
Assembly .....	21-12	<b>VALVE CLEARANCE ADJUSTMENT</b>	21-17
Disassembly .....	21-11		
Installation .....	21-11	<b>VALVE LIFTERS</b>	
Removal .....	21-11	Assembly .....	21-17
<b>ENGINE</b>		Disassembly .....	21-17
Assembly .....	21-30	Installation .....	21-16
Description .....	21-02	Removal .....	21-16
Disassembly .....	21-29		
Removal and Installation .....	21-23	<b>VALVE ROCKER ARM SHAFT</b>	
Supports—Front .....	21-03	Assembly .....	21-07
Supports—Rear .....	21-03	Disassembly .....	21-07
<b>EXHAUST EMISSION CONTROL SYSTEM</b>		Installation .....	21-06
Description .....	21-02	Removal .....	21-06
<b>EXHAUST MANIFOLD</b>			
Installation .....	21-09	<b>VENTILATION SYSTEM—CRANKCASE</b>	
Removal .....	21-09	Installation .....	21-10
		Removal .....	21-10
<b>FLYWHEEL</b>		<b>WATER PUMP</b>	
Installation .....	21-21	Installation .....	21-13
Removal .....	21-21	Removal .....	21-13



A2720-A

**FIG. 1—390 2-V Left Front View-Imco**

## **ENGINE**

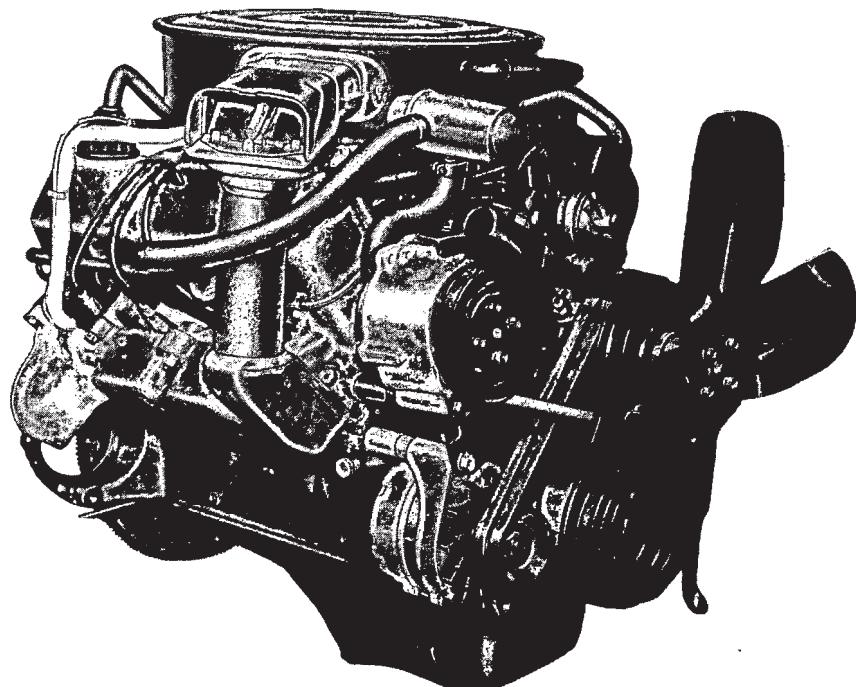
The 390 and the 428 V-8 engines (Figs. 1 and 2) have the same basic design. Differences in the engines are called out when they exist. Refer to Group 1 and Part 21-01 for the engine identification and application.

As engine identification tag is attached to the ignition coil bracket; refer to Part 21-01, Section 1 for the engine tag codes.

The 390 uses the Imco exhaust emission control system while the 428 4-V engine uses the Thermactor exhaust emission control system to keep exhaust gas contaminants at an acceptable level.

## **POSITIVE CLOSED-TYPE CRANKCASE VENTILATION SYSTEM**

All 390 and 428 engines are equipped with a positive closed-type crankcase ventilation system. The positive closed-type crankcase ventilation system substantially reduces air pollutants emitted by the crankcase ventilating system..



A2721-A

**FIG. 2—390 or 428 3/4 Right Front View-Thermactor**

## 2 IN-VEHICLE ADJUSTMENTS AND REPAIRS

Refer to Part 21-03 for cleaning and inspection procedures.

Refer to Part 21-01, Section 1 for test procedures.

When installing nuts or bolts that must be torqued (refer to the pertinent Part for torque specifications), oil the threads with light weight engine oil. Do not oil threads that require oil-resistant or water resistant sealer.

### ENGINE SUPPORTS

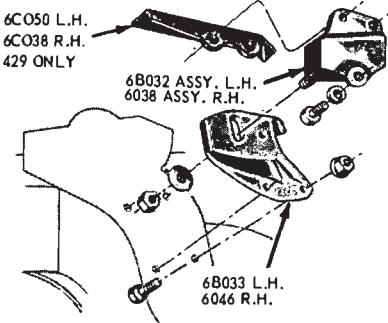
The front supports are located on each side of the cylinder block and the rear support is located at the transmission extension housing (Fig. 3).

#### FORD-MERCURY 390-428 FRONT SUPPORT INSULATORS

The procedures given apply to either a right or left installation.

##### Removal

###### 1. On a vehicle with an automatic



transmission, remove the transmission oil cooler inlet and outlet tubes from the retaining bracket on the cylinder block.

2. Remove the insulator to intermediate support bracket lock nut. If only one support is being removed, loosen the other support.

3. Using a jack and a wood block placed under the oil pan, raise the engine to allow just enough clearance for removal of the insulator(s).

4. Remove the insulator to engine locking bolts. Remove the insulator.

##### Installation

1. Position the insulator assembly on the engine. Install the insulator to engine locking bolts finger-tight.

2. Lower the engine carefully to make sure the insulator stud engages the intermediate support bracket mounting hole.

3. Install the lock nut on the insulator stud. Torque the insulator nut and bolts to specifications.

4. If only one support was removed, tighten the other support.

###### 5. On a vehicle with an automatic

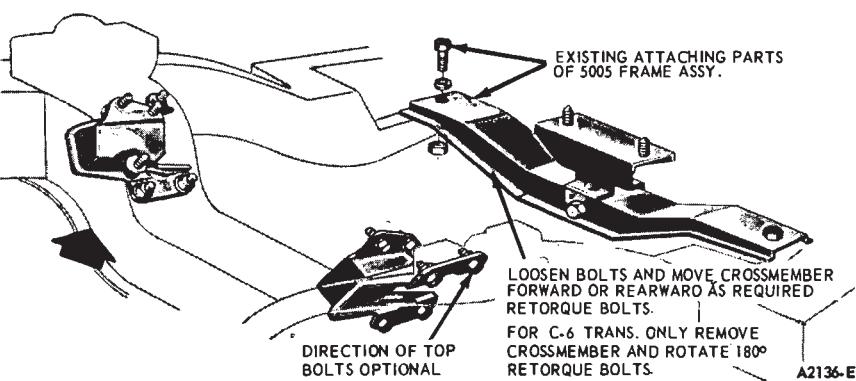
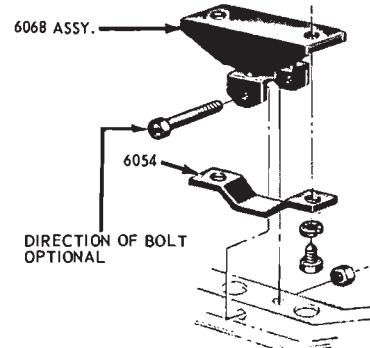


FIG. 3—Engine Front and Rear Supports—Ford-Mercury 390-428

transmission, install the transmission oil cooler inlet and outlet tubes in the retaining bracket on the cylinder block.

#### FORD-MERCURY 390-428 REAR SUPPORT INSULATOR

##### Removal

1. Remove the attaching bolts, nut, washers and insulator retainer.

2. Raise the engine slightly to gain clearance and remove the insulator assembly.

##### Installation

1. Position the insulator assembly and retainer. Install the insulator to extension housing flat washers, lock washers and bolts.

2. Lower the engine and install the insulator to frame crossmember bolt. If necessary, loosen the crossmember-to-frame mounting bolts and move the crossmember forward or rearward as required. Torque the insulator-to-frame crossmember and crossmember-to-frame mounting nuts and bolts to specifications.

#### MUSTANG-COUgar 428CJ FRONT SUPPORT INSULATORS

The procedures given apply to both right and left insulators.

##### Removal

(Refer to Figure 4)

1. Remove the air cleaner assembly.

2. Remove the bolts attaching the radiator shroud and leave it loose to allow fan clearance when raising the engine.

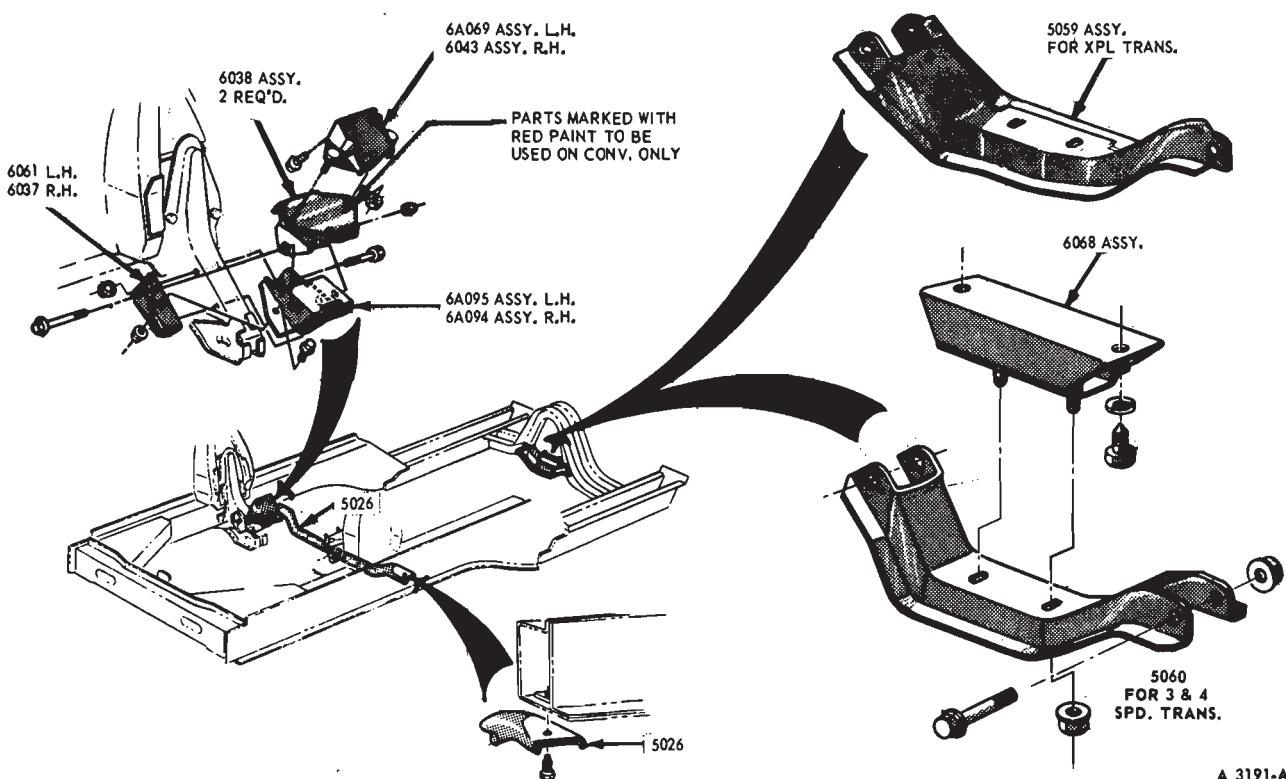
3. Remove the upper nut attaching the carburetor heat stove to the right exhaust manifold.

4. Raise the vehicle.

5. Remove the lower nut attaching the carburetor heat stove to the right exhaust manifold. Rotate the stove up and around the front of the manifold and position it under the battery carrier, out of the way.

6. Disconnect the power steering oil cooler lines at the engine oil filter adapter.

7. Remove the power steering line retainer and position lines out of the



**FIG. 4—Engine Front and Rear Supports—Mustang-Cougar 428 CJ**

way.

8. Position a floor jack under the engine.

9. Place a wood block between the oil pan and the jack and raise the engine slightly.

10. Remove the engine support to chassis thru bolt and nut on either or both sides.

11. Remove nuts and bolts attaching the engine support bracket to the chassis on either or both sides. Raise the engine.

12. Remove the nuts attaching the engine support insulators to the engine brackets and remove the insulators.

#### Installation

(Refer to Figure 4)

1. Position engine support insulator to the cylinder block bracket and install the attaching nuts. Torque to specifications.

2. Position engine support insulator to the chassis bracket and install attaching bolts and nuts. Torque to specifications.

3. Lower the jack enough to line up the holes and install the engine support to chassis thru bolt. Lower the engine completely and torque the thru bolt nut to specification.

4. Position the power steering line retainer to chassis and install attaching bolt.

5. Connect the power steering oil cooler line at the engine oil filter adapter.

6. Reposition the carburetor stove to the exhaust manifold and install the lower attaching nut.

7. Lower the vehicle.

8. Install the upper carburetor stove attaching nut.

9. Position the radiator shroud to the radiator and install the attaching bolts.

10. Install the air cleaner assembly.

#### MUSTANG-COUGAR 428CJ REAR SUPPORT INSULATOR

(Refer to Figure 4)

#### Removal

1. Raise the vehicle. Position a jack under the engine with a block of wood between the jack and the oil pan. Raise the engine enough to take the weight off the insulator.

2. Remove the nuts attaching the insulator to the removable cross-member.

3. Remove the thru-bolts attaching the cross-member to the frame and

remove the cross-member.

4. Remove the bolts attaching the support insulator to the transmission extension housing and remove the insulator.

#### Installation

1. Position the support insulator to the transmission extension housing and install and torque the attaching bolts.

2. Loosely install the cross-member to the lower insulator studs.

3. Raise the engine as necessary and install the cross-member to the chassis with the thru-bolts. Torque the thru-bolt nuts to specifications.

4. Lower the engine and tighten and torque the rear support attaching nuts.

5. Remove the jack and lower the car.

#### THERMATOR AIR PUMP DRIVE BELT ADJUSTMENT

The air supply pump drive belt should be properly adjusted at all times. A loose drive belt causes improper air pump operation. A belt that is too tight places a severe strain on the air pump bearings.

Properly tensioned drive belts mini-

mize noise and also prolong service life of the belt. A belt tension gauge should be used to adjust and check the belt tension. Any belt that has operated for a minimum of 10 minutes is considered a used belt, and, when adjusted, it must be adjusted to the tension shown in the specifications for used belts.

#### BELT TENSION

1. Install the belt tension tool (T63L-8620-A) on the drive belt and check the tension following the instructions of the tool manufacturer. Compare the belt tension to the specified belt tension and adjust as necessary.

2. If adjustment is necessary, loosen the air pump mounting and adjusting arm bolts (Fig. 5). Move the air pump toward or away from the engine until the correct tension is obtained. Use a suitable bar and pry against the pump rear cover to hold belt tension while tightening the mounting bolts. **Do not pry against the pump housing.** Remove the gauge. Tighten the air pump adjusting arm and mounting bolts. Install the tension gauge and check the belt tension.

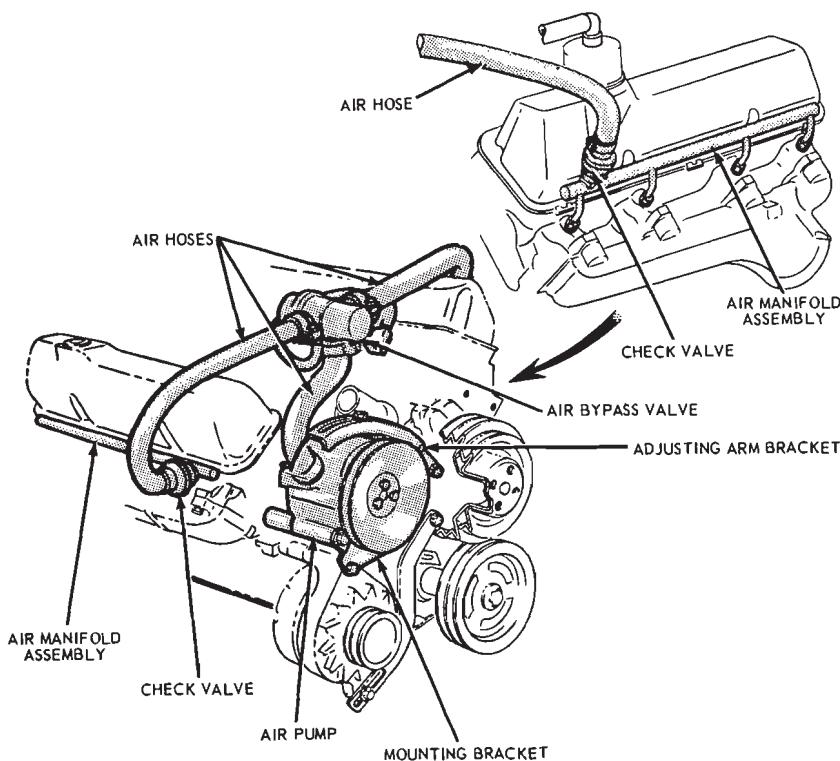


FIG. 5—Thermactor Exhaust Emission System Installation

#### THERMACTOR AIR PUMP DRIVE BELT REPLACEMENT

1. Loosen the air supply pump adjusting arm bolt (Fig. 5). Loosen the air supply pump to mounting bracket bolt, and push the air pump towards the cylinder block. Remove the drive belt.

2. Install a new drive belt. With a suitable bar, **pry against the rear cover of the air pump** to obtain the specified belt tension (refer to pertinent Part), and tighten the adjusting arm bolt. **Do not pry against the pump housing.** Adjust the belt tension (refer to pertinent Part) as necessary. Always use a belt tension gauge (Tool T63L-8620-A) to check belt tension.

3. Tighten the air supply pump to mounting bracket bolt.

#### THERMACTOR AIR BYPASS VALVE REPLACEMENT

1. Disconnect the air and vacuum hoses at the air bypass valve body (Fig. 5), and remove the valve.

2. Position the air bypass valve properly, and connect the air and vacuum hoses.

#### THERMACTOR CHECK VALVE REPLACEMENT

1. Disconnect the air supply hose at the valve. Use a 1-1/4 inch crowfoot wrench to unscrew the check valve assembly (the valve has a standard, pipe thread).

2. Clean the threads on the air manifold adapter with a wire brush. Install the check valve and torque it to specifications. Connect the air supply hose.

#### THERMACTOR AIR MANIFOLD

##### REMOVAL

1. Disconnect the air supply hose at the check valve and position the hose out of the way.

2. Loosen all of the air manifold to cylinder head tube coupling nuts (compression fittings). Then unscrew each one until it is free of the cylinder head. Grasp the air manifold at each end and pull it away from the cylinder head. Follow the same procedure to remove the other air manifold, if the engine is so equipped.

##### INSTALLATION

1. Position the air manifold(s) on the cylinder head. Be sure all the tube coupling nuts are aligned with the cylinder head. Screw each coupling nut into the cylinder head 1 to 2 threads. Tighten the tube coupling nuts.

2. Connect the air supply hose to the air manifold.

#### THERMACTOR AIR SUPPLY TUBE REPLACEMENT

Normally, air supply tubes would be replaced as necessary during cylinder head overhaul. A supply tube may

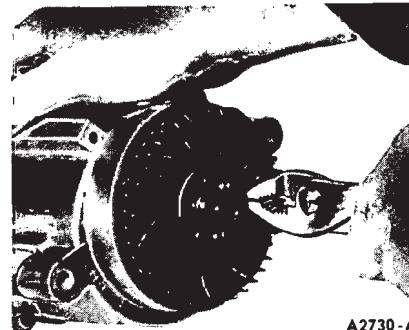


FIG. 6—Removing Thermactor Air Pump Centrifugal Filter Fan

be replaced without removing the cylinder head by removing the air manifold and using a hooked tool to pull the supply tubes.

For cleaning and inspection refer to Part 21-01, Section 3. Additionally, the air supply tubes could be inspected for badly eroded tips with the aid of a mirror, when the exhaust manifold(s) is removed.

#### **THERMACTOR AIR PUMP DRIVE PULLEY REPLACEMENT**

1. Loosen the air supply pump adjusting arm and mounting bolts to relieve the belt tension.
2. Remove the drive pulley attaching bolts and pull the drive pulley off the air pump shaft.
3. Position the drive pulley on the air supply pump shaft, and install the attaching bolts. Torque the bolts to specifications.
4. Position the drive belt and adjust the belt tension to specifications. Tighten the adjusting arm and mounting bolts.

#### **THERMACTOR AIR PUMP CENTRIFUGAL FILTER FAN REPLACEMENT**

1. Loosen the air supply pump adjusting arm bolt and mounting bracket bolt to relieve drive belt tension.
2. Remove the drive pulley attaching bolts and pull the drive pulley off the air pump shaft.
3. Pry the outer disc loose and then pull off the centrifugal filter fan as shown in Fig. 6. Care should be taken to prevent fragments from entering the air intake hole if the fan breaks when removing. **Do not attempt to remove the metal drive hub.**

4. Install the new filter fan by drawing it into position, using the pulley and bolts as an installer. Draw the fan evenly by alternately tightening the bolts, making certain that the outer edge of the fan slips into the housing.

A slight amount of interference with the housing bore is normal, and some initial noise during run-in may be expected.

#### **THERMACTOR AIR SUPPLY PUMP**

##### **REMOVAL**

1. Disconnect the air outlet hose at the air pump.
2. Loosen the adjusting arm to air pump and air pump to mounting

bracket bolts to relieve the drive belt tension.

3. Disengage the drive belt. Remove the mounting bolt and air pump.

##### **INSTALLATION**

1. Position the air pump on the mounting bracket and install the mounting bolt.

2. Place the drive belt in the pulleys and attach the adjusting arm to the air pump. Adjust the drive belt tension to specifications and tighten the adjusting arm and mounting bolts.

3. Connect the air outlet hose to the air pump.

#### **THERMACTOR AIR PUMP RELIEF VALVE REPLACEMENT**

**Do not disassemble the air pump to replace the relief valve, but remove it from the engine.**

1. Position Tool T66L-9A486-D on the air pump and remove the relief valve with the aid of a slide hammer (T59L-100-B).

2. Position the relief valve on the pump housing and hold Tool T66L-9A486-B on the relief valve. Use a hammer to tap the tool lightly until the relief valve is seated.

#### **THERMACTOR RELIEF VALVE PRESSURE-SETTING PLUG REPLACEMENT**

1. Compress the three locking tabs inward (together) and remove the plastic pressure-setting plug.

2. Before installing the new plug, be sure that the plug is the correct one. The correct plug for this engine should be color-coded blue.

3. Insert the plug in the relief valve hole, and push the plug in until it snaps into place.

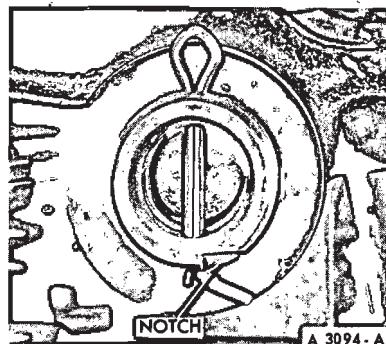
#### **VALVE ROCKER ARM SHAFT ASSEMBLY**

##### **REMOVAL**

1. Remove the air cleaner.
2. On Thermactor engines, disconnect the air hoses as necessary for accessibility and position them out of the way.

3. Disconnect the spark plug wires at the spark plugs. Remove the wires from the bracket on the valve rocker arm cover(s) and position the wires out of the way.

To remove the right valve rocker arm cover, remove the carburetor



**FIG. 7—Typical Installation Identification Mark-Rocker Arm Shaft Assembly**

choke air heat tube, and the heat chamber air inlet tube. Remove the crankcase ventilation regulator valve or vent tube from the rocker cover.

4. Remove the valve rocker arm cover(s).

If the left cover is removed, position the wire loom out of the way.

5. Crank the engine until the No. 1 piston is on TDC at the end of the compression stroke. Rotate the crankshaft damper an additional 45 degrees (identified by XX on the damper).

6. On the right cylinder head, start at the No. 4 cylinder and loosen the valve rocker arm shaft support bolts in sequence, two turns at a time. After the bolts are all loosened, remove the valve rocker arm shaft assembly and the oil baffle plate. On the left cylinder head, start at the No. 5 cylinder and follow the same procedure on the left valve rocker arm shaft support bolts. **This procedure must be followed to avoid damage to the rocker shaft.**

##### **INSTALLATION**

1. Apply Lubriplate to the pad end of the rocker arms, to the tip of the valve stems, and to bolt ends of the push rods.

2. If the crankshaft damper has been removed, reposition it on the XX mark, following the procedure under Step 4 of Removal above.

3. Position the baffle plate and the valve rocker arm shaft assembly(ies) on the cylinder heads with the valve push rods in place and the rocker shaft support bolts finger-tight. **Be sure the shaft is positioned so that the oil holes are to the bottom. Also, the identification notch (Fig. 7) must be downward and toward the front on the right bank, or toward the rear on the left bank.**

4. On the right cylinder head, start at the No. 4 cylinder and tighten the bolts in sequence, two turns at a time, until the supports fully contact the cylinder head. Torque the bolts in sequence to specifications.

5. On the left cylinder head, start at the No. 5 cylinder and follow the same procedure for the left valve rocker arm shaft support bolts. The additional time consumed in this procedure will permit the hydraulic lifters to leak down. This will minimize the possibility of bending the push rods, valves or rocker arms. Be sure that the hydraulic lifters have leaked down to their normal operating position before cranking the engine. This is necessary in order to avoid possible damage to the valves, push rods or valve rocker arms.

6. Clean the valve rocker arm cover(s). Apply oil-resistant sealer to one side of new cover gasket(s). Lay the cemented side of the gasket(s) in place in the cover(s).

7. Position the cover(s) on the cylinder head(s). Make sure the gasket seats evenly all around the head. Install the bolts (and the wire loom clamps on the left cover). The cover is tightened in two steps. Torque the bolts to specifications. Two minutes later, torque the bolts to the same specifications.

On a vehicle with power brakes, if the left cover was removed, connect the brake booster vacuum line to the intake manifold. On Thermactor engines connect the air hoses.

If the right cover was removed, install the carburetor choke air heat tube, and connect the automatic choke heat chamber air inlet tube. Install the crankcase ventilation

regulator valve in the rocker cover.

8. Connect the spark plug wires. Install the air cleaner.

#### DISASSEMBLY

1. Remove the cotter pins from each end of the valve rocker arm shaft. Remove the flat washer and spring washer from each end of the shaft.

2. Slide the rocker arms, springs and supports off the shaft. Be sure to identify all the parts.

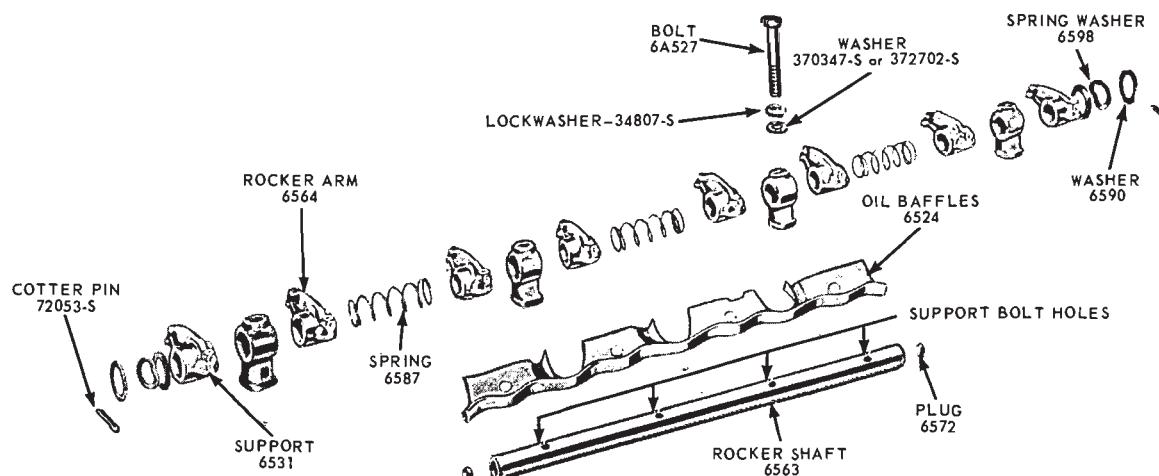
3. If it is necessary to remove the plugs from each end of the shaft, drill or pierce one plug. Then insert a steel rod through the drilled plug and knock out the plug on the opposite end. Working from the open end, knock out the remaining plug.

#### ASSEMBLY

1. Oil all the moving parts including valve stems with engine oil. Apply Lubriplate to the pad of the valve rocker arms.

2. If the plugs were removed from the ends of the shaft, use a blunt tool or large diameter pin punch, and install a plug, cup side out, in each end of the rocker arm shaft.

3. Install the rocker arms, supports and springs in the order shown in Fig. 8. Be sure the oil holes in the shaft are facing downward. When properly assembled, the identification notch (Fig. 7) on the right rocker shaft assembly must be facing downward and toward the front of the engine. On the left rocker shaft, the notch is downward and toward the rear. Complete the assembly by installing the remaining flat washer, spring washer and cotter pin.



A3095-A

FIG. 8—Valve Rocker Arm Shaft Assembly

#### INTAKE MANIFOLD

##### REMOVAL

1. Drain the cooling system. Remove the hood. Remove the air cleaner.

Disconnect the accelerator cable at the carburetor. Remove the accelerator retracting spring. Remove the accelerator cable bracket from the intake manifold, and position the cable and bracket assembly out of the way.

On a vehicle with an automatic transmission, remove the kickdown rod retracting spring. Disconnect the kickdown rod at the carburetor and the spacer vacuum line.

2. Disconnect the coil high tension lead and the primary wire at the distributor. Disconnect the oil pressure sending unit wire at the sending unit.

3. Disconnect the spark plug wires at the spark plugs and remove the wires from the ignition harness brackets on the valve rocker arm covers. Remove the distributor cap and spark plug wires as an assembly. Disconnect the distributor vacuum hoses at the distributor.

4. Disconnect the carburetor fuel inlet line at the fuel filter. Remove the automatic choke air heat tube and the heat chamber air inlet tube. Disconnect the brake booster vacuum line at the intake manifold and at the flexible hose. Remove the vacuum line.

5. Remove the distributor hold down bolt and clamp, and remove the distributor.

6. Disconnect the radiator upper hose at the thermostat housing. Disconnect the heater hoses from the intake manifold. Disconnect the water

temperature sending unit wire at the sending unit. Disconnect the heater hose at the water pump and remove it from the automatic choke housing bracket.

7. Loosen the clamp on the water pump bypass hose, and slide it toward the water pump.

8. Remove the crankcase ventilation regulator valve from the right

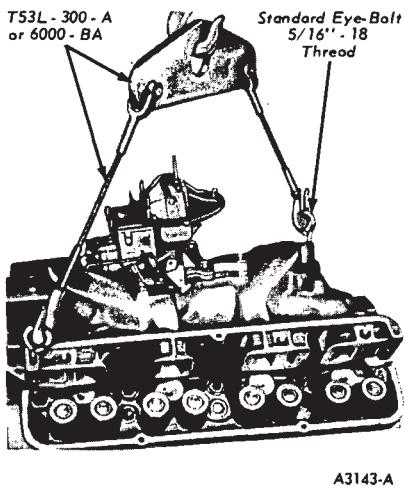


FIG. 9—Removing or Installing Intake Manifold

valve rocker arm cover. On Thermactor engines, disconnect the air lines and hoses as necessary for accessibility. Remove the valve rocker arm covers. Position the wire loom attached to the left valve rocker arm cover out of the way.

9. Refer to Valve Rocker Arm Shaft Assembly—Removal, and remove the valve rocker arm shaft assemblies by following steps 4 and 5.

10. Remove the valve push rods in sequence, and place them in a rack so they can be installed in the same location.

11. Remove the intake manifold attaching bolts.

12. Install standard eye bolts with 5/16-18 threads in the left front and right rear rocker arm cover screw holes and attach the engine lifting sling (Fig. 9).

13. Use a hoist to raise the manifold. Remove the intake manifold. Remove the intake manifold gaskets and seals.

14. If the intake manifold is to be disassembled, identify the distributor vacuum hoses to facilitate proper connection; then remove the hoses. Remove the thermostat housing, thermostat and gasket. Remove the carburetor, spacer and gaskets. Remove the

coolant temperature sending unit.

## INSTALLATION

The intake manifold assembly is shown in Fig. 10.

1. Clean the mating surfaces of the intake manifold, cylinder heads and cylinder block. Use a suitable solvent to remove all traces of oil.

2. If the intake manifold was disassembled, install the carburetor, spacer and gaskets. Coat the thermostat gasket with water-resistant sealer and place it in position on the intake manifold. Install the thermostat and thermostat housing. Coat the coolant temperature sending unit threads with electrical conductive sealer, and install the sending unit in the intake manifold. Install the distributor vacuum hoses. Be sure the hoses are properly connected.

3. Coat the intake manifold and cylinder block seal surfaces with contact cement. Apply a non-hardening sealer to the mating lines of the cylinder heads and cylinder block.

4. Position new seals on the cylinder block and new gaskets on the cylinder heads. Be sure the seals are properly positioned during installation as the adhesive sticks to the seals immediately on contact. Position the manifold gasket slots over the end tabs on the seals. Coat these four connections with a non-hardening sealer. Be sure the holes in the gaskets are aligned with the holes in the cylinder heads.

5. Install the eye bolts in the intake manifold and attach the engine lifting sling.

6. Use a hoist to lower the intake manifold on the engine (Fig. 9), and at the same time engage the coolant outlet nipple with the water pump bypass hose.

7. After the intake manifold is in place, run a finger around the seal area to make sure the seals are in place. If the seals are not in place, remove the intake manifold and reposition the seals.

8. Be sure the holes in the manifold gaskets and manifold are in alignment. Coat the underside of the heads of the attaching bolts with oil-resistant, non-hardening sealer.

9. Install the distributor (as detailed in Group 22) to properly locate the manifold on the cylinder block. Install the manifold bolts. Torque the intake manifold bolts in two steps (Fig. 11).

Torque all bolts in sequence to specifications.

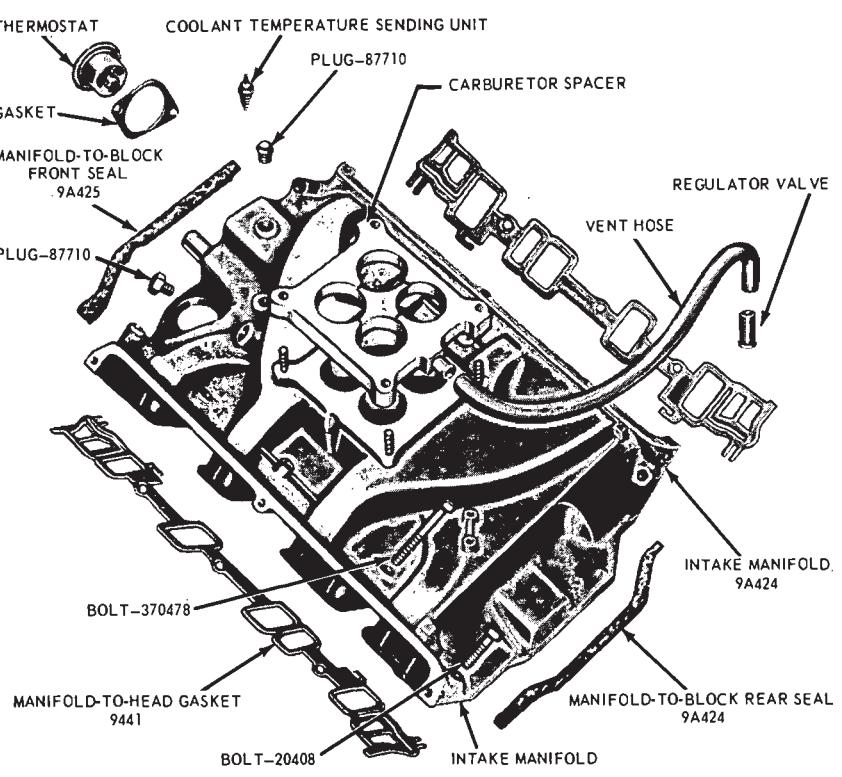
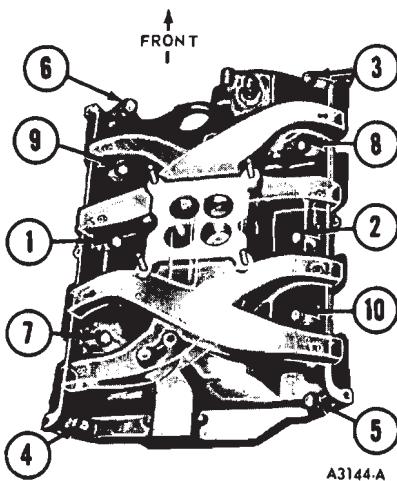


FIG. 10—Typical Intake Manifold Assembly 390 and 428 V-8, Except 428 Police



**FIG. 11—Intake Manifold Torque Sequence**

After completing the remaining assembly steps; operate the engine until it reaches normal operating temperature; then retorque the manifold bolts in sequence to specifications.

10. Remove the engine lifting sling and eye bolts.

11. Slide the water pump bypass hose clamp into position. Connect the coolant temperature sending unit wire. Connect the heater hoses and the radiator upper hose. Install the water pump heater hose in the automatic choke housing bracket.

12. Refer to Valve Rocker Arm Shaft Assembly Installation, and install the valve rocker arm shaft assembly by following steps 1 thru 7.

13. Clean the valve rocker arm covers. Apply oil-resistant sealer to one side of new cover gaskets. Lay the cemented side of the gaskets in place in the covers. Install the valve rocker arm covers, bolts and wire loom clamps. Tighten the covers in two steps. First, torque the bolts to specifications. Two minutes later, torque the bolts to the same specifications.

14. Install the positive crankcase ventilation system components. On Thermactor engines connect the hoses.

15. Connect the brake booster vacuum line and connect the flexible hose.

16. Using a new clamp, connect the carburetor fuel inlet line to the fuel filter; then connect the distributor vacuum hoses. Be sure the vacuum hoses are properly connected. Install the automatic choke air heat tube and air inlet tube.

17. Install the distributor cap. Connect the spark plug wires.

18. Connect the oil pressure sending unit wire, coolant temperature sending unit wire, coil high tension lead and coil primary wire.

Install the accelerator cable bracket on the intake manifold. Connect the accelerator cable to the carburetor. Install the accelerator retracting spring.

On a vehicle with an automatic transmission, connect the kickdown rod. Install the kickdown rod retracting spring, and the spacer vacuum line.

19. Fill and bleed the cooling system.

20. Install the air cleaner, start the engine, and check and adjust the ignition timing. Operate the engine until engine temperatures have stabilized and adjust the engine idle speed and idle fuel mixture. Retorque the intake manifold bolts to specifications.

21. Install the hood.

## EXHAUST MANIFOLDS

### FORD-MERCURY 390-428

#### Removal

1. Disconnect the exhaust manifold from the muffler inlet pipe.

2. Remove the automatic choke air heat tube and air inlet tube from the right exhaust manifold.

3. Remove the attaching bolts and flat washers and remove the exhaust manifolds.

#### Installation

1. Clean the mating surfaces of the exhaust manifold and cylinder head. Scrape the gasket material from the mounting flange of the exhaust manifold and muffler inlet pipe.

2. Apply graphite grease to the cylinder head mating surface of the exhaust manifold.

3. Position the exhaust manifold on the cylinder head and install the attaching bolts and flat washers. Working from the center to the ends, torque the attaching bolts to specifications.

4. Install the automatic choke air heat tube and air inlet tube on the right exhaust manifold.

5. Position a new gasket between the exhaust manifold and the muffler inlet pipe. Install and torque the attaching nuts to specifications.

6. Start the engine and check for exhaust leaks.

## EXHAUST MANIFOLDS

### MUSTANG AND COUGAR 428 CJ

#### Removal

1. Remove the air cleaner, heat shroud and brackets, choke and vacuum tubes from the carburetor and exhaust manifold. Remove the 2 studs as they are manifold attaching bolts (right side).

2. Remove the 3 forward manifold attaching bolts (right side).

3. Raise the vehicle.

4. Remove the idler arm bracket from the frame and lower it to obtain clearance.

5. Disconnect the starter cable and remove the starter.

6. Remove the remaining manifold bolts (right side).

7. Remove the rear hanger clamps on outlet pipes, and the bolts on the muffler hangers.

8. Remove both inlet pipes from the manifolds.

9. Remove the Pitman arm from sector shaft, as detailed in Group 13.

10. On vehicles having power steering, remove the cylinder bracket from the frame for clearance.

11. Lower the exhaust system.

12. If removing the left manifold on a vehicle having a manual transmission, disconnect the clutch linkage and equalizer bracket from the engine.

13. Position a jack and wood block under the oil pan. Raise the engine slightly.

14. Remove the insulator brackets from the crossmember.

15. Remove the right and left insulators from the engine.

16. If removing the left manifold, remove the flex coupling at the steering shaft. Remove the steering gear from the frame.

17. If removing a left manifold, remove the attaching bolts and remove the manifold. The right manifold can be removed at this point.

#### Installation

1. Clean the mating surfaces of the exhaust manifold and cylinder head. Scrape the gasket material from the mounting flange of the exhaust manifold and muffler inlet pipe.

2. Apply graphite grease to the cylinder head mating surface of the exhaust manifold.

3. Install the left manifold, position right manifold to cylinder head and

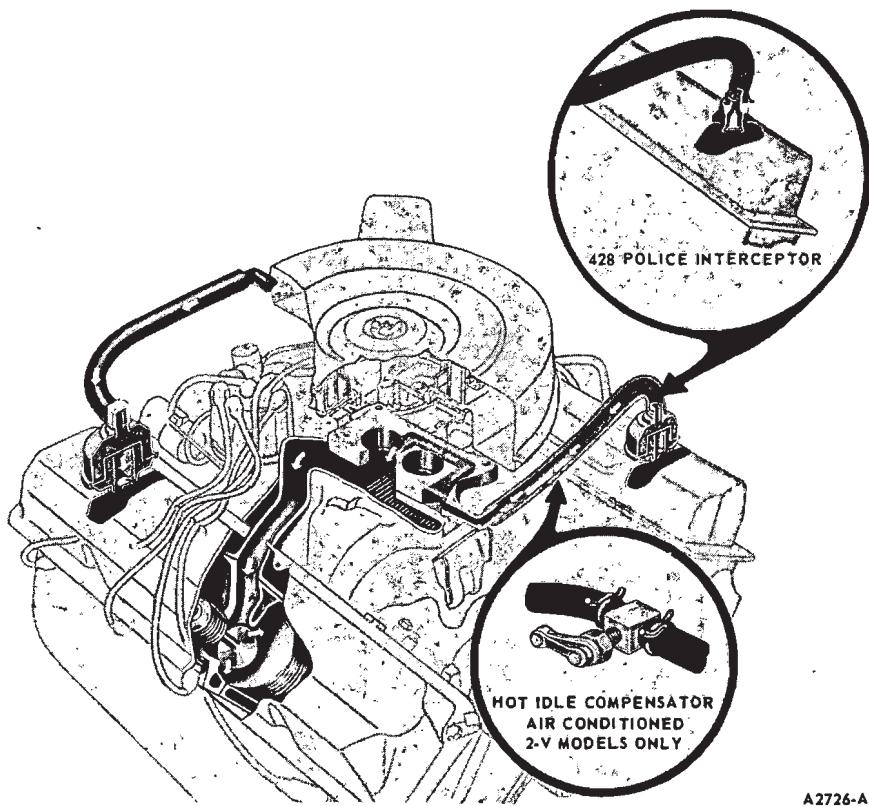


FIG. 12—Positive Closed-Type Crankcase Ventilation System—390 and 428 Engines Except 428 Police Interceptor

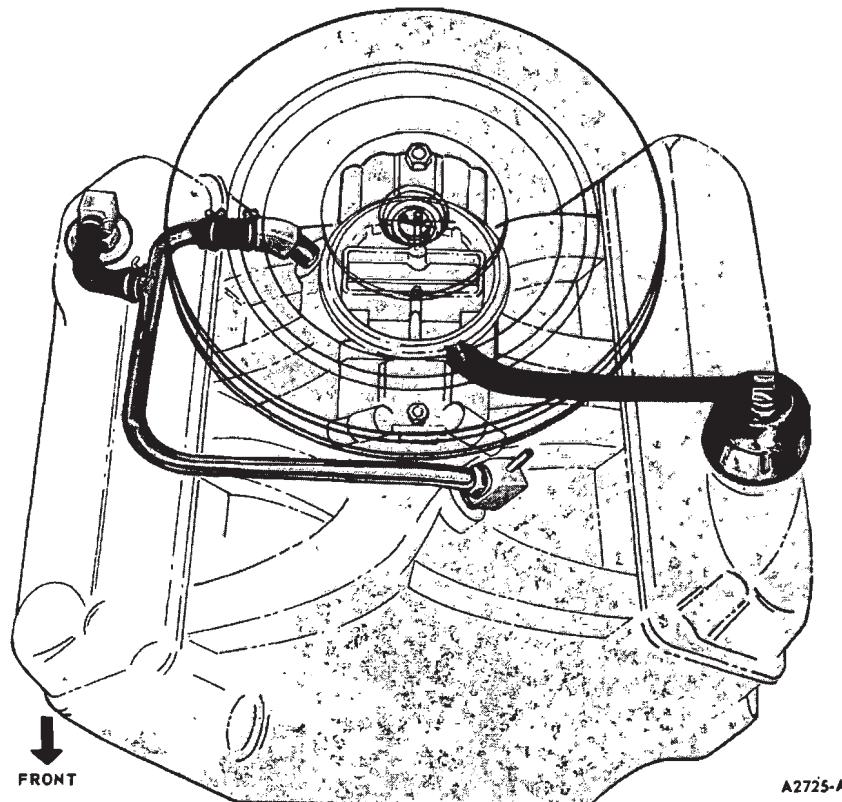


FIG. 13—Positive Closed-Type Crankcase Ventilation System—428 Police Interceptor

tighten all bolts that can be tightened from below. Torque bolts to specifications.

4. If working on a left manifold, install the steering gear to frame and torque bolts to specifications. Install flex coupling to steering shaft.

5. Install right and left insulator to engine and torque bolts to specifications.

6. Install insulators to crossmember and torque bolts to specifications.

7. Install Pitman arm and torque nut to specifications.

8. Install the starter and connect cable.

9. If equipped with power steering, install power cylinder bracket to frame.

10. Install idler arm and torque bolts to specifications.

11. Install clutch linkage and equalizer bracket if equipped with a manual transmission.

12. Install inlet pipes to exhaust manifolds.

13. Install mufflers and hangers.

14. Lower the vehicle.

15. Torque remaining manifold bolts to specifications.

16. Install heat shroud and brackets, 2 manifold studs and nuts.

17. Install carburetor-to-manifold heat tubes.

18. Install air cleaner.

19. Start engine and check for leaks.

#### POSITIVE CLOSED-TYPE CRANKCASE VENTILATION SYSTEM

##### REMOVAL

1. Disconnect the vent hose and remove the air cleaner.

2. Remove the vent hose and oil filler cap (Fig. 12 or 13).

3. Disconnect the inlet vent hose from the carburetor spacer or inlet vent tube assembly (428 Police). Grasp the crankcase ventilation regulator valve, and pull it upwards and out of the grommet in the right valve rocker arm cover or oil separator (if so equipped).

4. On 428 Police engines, remove the inlet vent tube assembly from the intake manifold.

##### INSTALLATION

1. Clean the hoses, inlet vent tube assembly (if so equipped), oil filler cap, oil separator (if so equipped), and carburetor spacer (or intake manifold connections). Follow the clean-

ing procedures in Part 21-01, Section 3. **Do not clean the crankcase ventilation regulator valve. It should be replaced at the interval specified in the maintenance schedule.**

2. On 428 Police engines, install the inlet vent tube assembly on the intake manifold.

3. Install the regulator valve in the vent hose. Connect the vent hose to the carburetor spacer or inlet vent tube tee, and install the regulator valve in the valve rocker arm cover grommet or oil separator (if so equipped). Be sure the grommet is properly seated around the regulator valve.

4. Install the air cleaner, oil filler cap, and vent hose. Connect the vent hose to the air cleaner.

## CYLINDER HEADS

### REMOVAL

If a cylinder head is to be replaced, follow the procedures under Cylinder Head Disassembly and Assembly, and transfer all valves, springs, spark plugs, etc., to the new cylinder head. Clean and inspect all parts and reface the valves (refer to Part 21-01) before assembling the used parts to the new cylinder head. Check all assembly clearances.

1. On Thermactor engines, disconnect the air lines and hoses as necessary for accessibility. Remove the intake manifold, crankcase ventilation system components, carburetor, and thermostat housing as an assembly following the procedure under Intake Manifold Removal.

2. On all engines disconnect the exhaust manifold(s) at the muffler inlet pipe(s). Leave the manifold(s) attached to the cylinder head(s).

3. If the left cylinder head is to be removed, remove the ignition coil and engine identification tag.

Remove the power steering pump mounting bracket bolts, and position the power steering pump and bracket assembly out of the way. **Leave the fluid lines attached to the power steering pump.**

On a vehicle with air conditioning, remove the compressor mounting bracket bolts and position the compressor out of the way.

4. Remove the cylinder head bolts.

5. Do not pry the cylinder head(s) loose from the cylinder block. Lift the cylinder head(s) off the block. Remove and discard the cylinder head gasket. Remove the baffle plate.

### INSTALLATION

1. Clean the cylinder head and cylinder block gasket surfaces.

2. Inspect the cylinder head, following the procedures in Part 21-01, Section 3. **If the cylinder head was removed for a cylinder head gasket replacement, check the flatness of the cylinder head and block gasket surfaces (Part 21-01, Section 3).**

3. All engines use a specially treated composition gasket. **Do not apply sealer to a composition gasket.** Guided by the word FRONT on the gasket, install the gasket over the cylinder head dowels.

4. Place the cylinder head on the engine.

5. Install the cylinder head bolts. The cylinder head bolts are tightened in three progressive steps.

On all engines torque all the bolts in sequence (Fig. 14) to 70 ft-lbs. Then torque them to 80 ft-lbs and finally to specifications. When cylinder head bolts have been tightened following this procedure, it is not necessary to retorque the bolts after extended operation. However, on cylinder heads with composition gaskets, the bolts may be checked and retorqued if desired.

6. On the left cylinder head, install the ignition coil, engine identification tag and power steering pump. Adjust the power steering pump belt tension to specifications.

On a vehicle with an air conditioner, install the compressor mounting bracket with the power steering pump. Adjust the compressor drive belt tension to specifications.

7. Position a new gasket between the muffler inlet pipes and each exhaust manifold, and connect the inlet pipes to the manifolds. Torque the attaching nuts to specifications.

If the left cylinder head was removed, install the ignition coil and the fuel filter (428 Police Interceptor V-8).

8. Install the baffle plate. Install the intake manifold and related parts following the procedure under Intake Manifold Installation. On Thermactor engines connect the hoses.

### DISASSEMBLY

1. Remove the Thermactor exhaust emission control system components. Remove the exhaust manifold(s).

2. Taking special care not to damage the exposed machined surfaces, remove the spark plugs. Clean the carbon out of the cylinder head com-

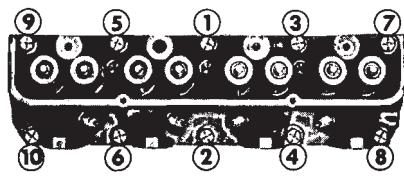
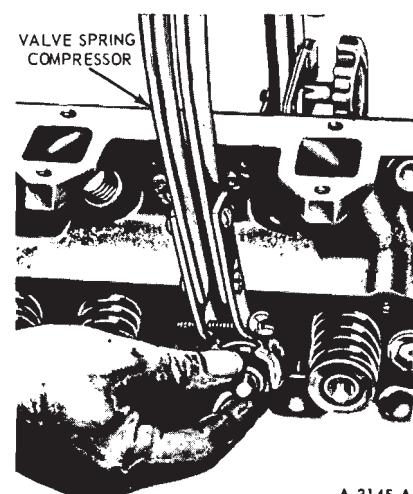
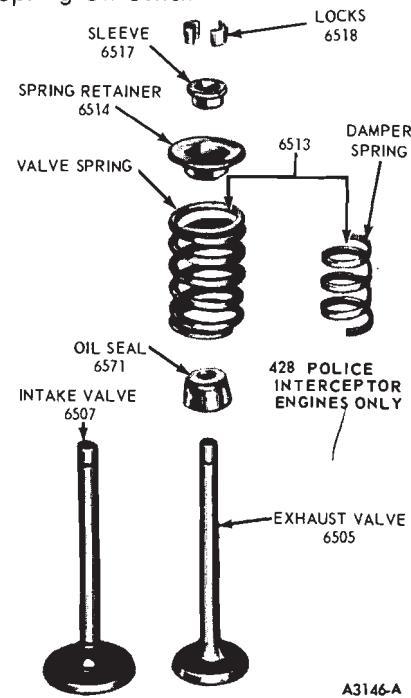


FIG. 14—Cylinder Head Bolt Torque Sequence



A 3145-A

FIG. 15—Compressing Valve Spring-On Bench



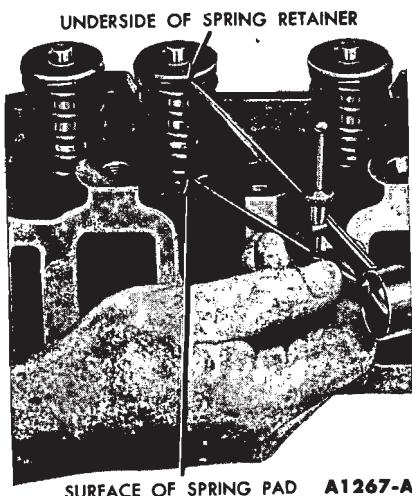
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FIG. 16—Typical Valve Assembly

bustion chambers before removing the valves.

3. Compress the valve springs (Fig. 15). Remove the spring retainer locks and release the spring.

**On the 428 Police engines only, in-**



**FIG. 17**—Valve Spring Assembled Height

spect the valve springs before removal to determine if the damper spring(s) is intertwined with the valve spring(s). If this condition exists, replace all defective or worn components (refer to inspection procedures in Part 21-01, Section 3).

4. Remove the sleeve, spring retainer, spring (and damper spring if applicable), stem seal and valve. Discard the valve stem seals. Identify all valve parts.

Clean, inspect and repair all parts as shown in Part 21-01, Section 2 and 3.

#### ASSEMBLY

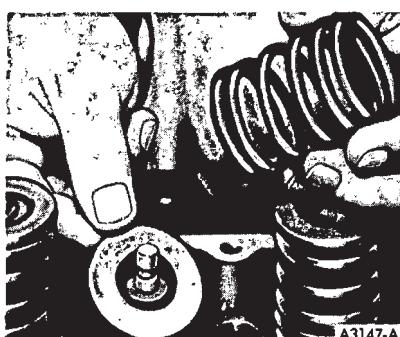
1. Oil each stem with heavy MS oil and install each valve (Fig. 16) in the port from which it was removed or to which it was fitted. Install a new stem seal on the valve. The exhaust valve stem seal is approximately 0.025 inch shorter in over-all height than the intake valve stem seal (identified with yellow paint); therefore, be sure the seals are installed on the proper valves.

2. Install the valve spring (closed coils downward) over the valve, and install the spring retainer and sleeve.

On the 428 Police engines only, make sure the damper spring is installed in the valve spring so that the coil end of the damper spring is 135 degrees counterclockwise from the coil end of the valve spring.

3. Compress the spring and install the retainer locks (Fig. 15).

4. Measure the assembled height of the valve spring from the surface of the cylinder head spring pad to the underside of the spring retainer with dividers (Fig. 17). Check the dividers



**FIG. 18**—Installing Valve Spring Spacer

against a scale. If the assembled height is greater than specified, install the necessary 0.030-inch thick spacer(s) between the cylinder head spring pad and the valve spring (Fig. 18) to bring the assembled height to the recommended specifications.

Do not install spacers unless necessary. Use of spacers in excess of recommendations will result in overstressing the valve springs and overloading the camshaft lobes which could lead to spring breakage and worn camshaft lobes.

5. Install the exhaust manifold(s).
6. Install the spark plugs.
7. Install the Thermactor exhaust emission system components.

#### VALVE SPRING, RETAINER AND STEM SEAL REPLACEMENT

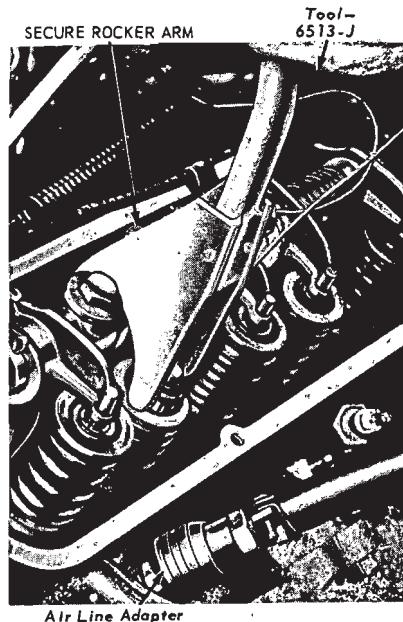
Broken valve springs, or defective valve stem seals and retainers may be replaced without removing the cylinder head provided damage to the valve or valve seat has not occurred.

1. Remove the valve rocker arm cover(s) and rocker arm shaft assembly(ies), following the procedures under Valve Rocker Arm Shaft Assembly Removal.

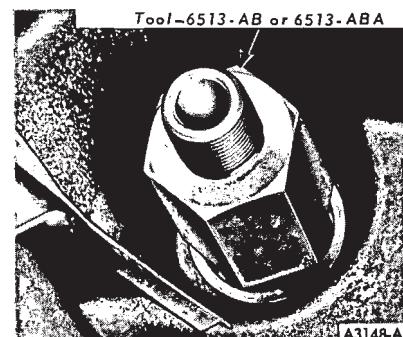
2. Remove both push rods of the cylinder to be serviced.

3. Tighten the valve rocker arm support bolts evenly and alternately, two turns at a time, until they are snug. Push the rocker arm to one side and secure it in this position (Fig. 19). If an end valve is to be worked on, it will be necessary to remove the rocker arm from the shaft.

4. Remove the applicable spark plug. Install an air adapter in the spark plug hole and connect the air supply hose to the adapter (Fig. 20). Turn on the air supply. Air pressure may turn the crankshaft until the piston reaches the bottom of its stroke.



**FIG. 19**—Compressing Valve Spring-In Chassis



**FIG. 20**—Installing Air Adapter Tool in Spark Plug Hole

5. Compress the valve spring and remove the valve retainer locks from the valve (Fig. 19).

6. Remove the valve spring and related parts. Remove the valve stem seal (Fig. 21). If air pressure has forced the piston to the bottom of the cylinder, any removal of air pressure will allow the valve(s) to fall into the cylinder. A rubber band, tape or string wrapped around the end of the valve stem will prevent this condition and will still allow enough travel to check the valve for binds.

7. Inspect the valve stem for damage. Rotate the valve and check the valve stem tip for eccentric movement during rotation. Move the valve up and down through normal travel in the valve guide and check the stem for binds. If the valve has been dam-

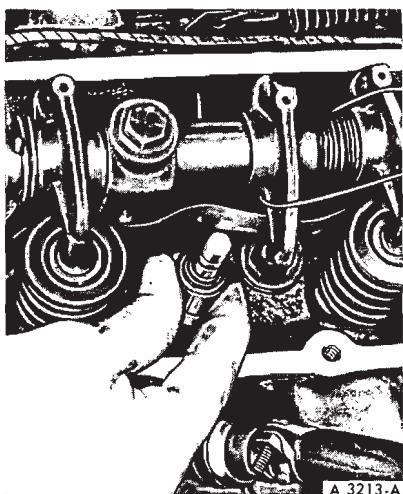


FIG. 21—Removing Valve Stem Seal

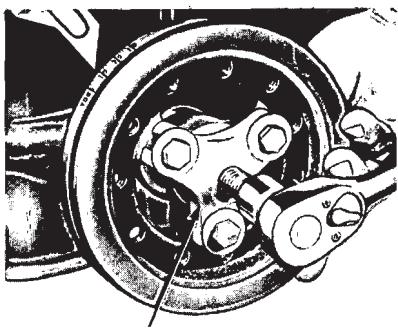


FIG. 22—Removing Crankshaft Damper

aged, it will be necessary to remove the cylinder head for repairs as outlined in Part 21-01, Section 2.

8. If the condition of the valve proved satisfactory, hold the valve in the closed position and apply the air pressure within the cylinder.

9. Inspect the valve stem seal for a cracked, torn or brittle condition, and replace it if necessary. Oil the valve stem with heavy MS oil and install the seal. The exhaust valve stem seal (identified by yellow paint) is approximately 0.025 inch shorter in overall height than the intake valve stem seal; therefore, be sure the proper seal is installed.

10. Install the valve springs, retainer and sleeve over the valve stem. On 428 Police engines only, make sure the valve damper spring is installed in the valve spring so that the coil end of the damper spring is 135 degrees counterclockwise from the coil end of the valve spring.

11. Compress the valve spring (Fig. 19), and install the valve retainer locks. Tap the valve stem tip with a

soft mallet to make certain that the retainer locks are properly seated.

12. Remove the air line and adapter. Install the spark plug. Remove the wire securing the valve rocker arm and slide the rocker arm in position. Install the end rocker arm(s), if they were removed.

13. Crank the engine until No. 1 piston is on TDC at the end of the compression stroke. Rotate the crankshaft damper an additional 45 degrees (identified by XX on the damper).

14. Loosen the valve rocker arm support bolts evenly and alternately two turns at a time, until spring tension is removed. Apply Lubriplate to both ends of the push rod. Position the push rod within the rocker arm socket and the valve lifter seat.

15. Oil the rocker arms and shaft with heavy MS oil. Tighten the rocker arm shaft support bolts evenly and alternately, two turns at a time, until they are snug. Torque the bolts to specifications.

16. Install the spark plug wires. Check the valve clearance and correct if necessary (Part 21-01, Section 2).

17. Clean the valve rocker arm cover(s). Apply oil-resistant sealer to one side of new cover gasket(s). Lay the cemented side of the gasket(s) in place on the cover(s).

Position the cover(s) on the cylinder head(s). Make sure the gasket seats evenly all around the head. Install the bolts (and the wire loom clamps on the left cover). The cover is tightened in two steps. Torque the bolts to specifications. Two minutes later, torque the bolts to the same specifications. On Thermactor engines, connect the air hoses.

18. Connect the automatic choke heat chamber air inlet tube. Install the air cleaner.

## WATER PUMP

### REMOVAL

1. Drain the cooling system. Remove the bolts and nuts attaching the power steering pump mounting bracket. Remove the power steering pump and mounting bracket as an assembly, and position it to one side.

2. Remove the power steering, air conditioning, and Thermactor drive belts, if so equipped.

3. Disconnect the radiator lower hose and heater hose at the water pump. Remove the radiator upper support and fan guard. Remove the fan belt(s), fan, fan spacer or fan

drive clutch and pulley.

4. Remove the four bolts attaching the pump to the block. Remove the pump and gaskets.

### INSTALLATION

Before a water pump is re-installed, check it for damage. If it is damaged and requires repair, replace it with a new pump.

1. If a new water pump is to be installed, remove the heater hose fitting from the old pump and install it on the new pump. Remove all gasket material from the mounting surfaces of the cylinder front cover or block and water pump.

2. Position a new gasket, coated on both sides with sealer, on the cylinder block; then install the pump.

3. Install the attaching bolts and torque them to specifications.

Install the power steering pump and bracket assembly. Install the power steering, air conditioning, and Thermactor drive belts, if so equipped.

4. Install the pulley, spacer or fan drive clutch and fan. Torque the cap-screws evenly and alternately to specifications. Then, check the fan drive clutch flange-to-water pump hub (if so equipped) for proper mating. Install the belt(s) and adjust the belt tension to specifications. Connect the radiator hose and heater hose. Install the radiator upper support and fan guard.

5. Fill and bleed the cooling system. Operate the engine until normal operating temperatures are reached and check for leaks.

### CYLINDER FRONT COVER AND TIMING CHAIN

If the cylinder front cover is being removed to replace the gasket or to replace the fuel pump drive eccentric, it is not necessary to check the timing chain deflection. For cylinder front cover gasket replacement, it is not necessary to remove the timing chain and sprockets.

### REMOVAL

1. Drain the cooling system and the crankcase. Disconnect the battery ground cable.

2. Disconnect the radiator upper hose at the thermostat housing. Disconnect the radiator lower hose at the water pump. On a vehicle with automatic transmission, disconnect the transmission oil cooler lines from the

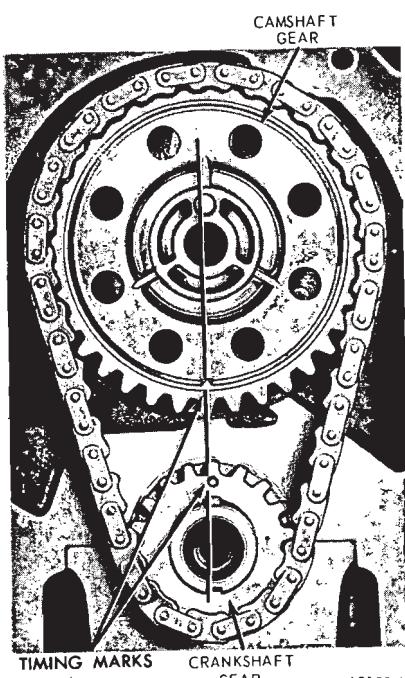


FIG. 23—Aligning Timing Marks

radiator.

3. Remove the radiator.

4. Disconnect the heater hose at the water pump and remove the hose from the choke housing clamp. Slide the water pump bypass hose clamp toward the engine.

On a vehicle with power steering, remove the power steering pump bracket mounting bolts. Position the pump assembly to the left side of the vehicle in a position that will prevent the fluid oil from draining out.

On a vehicle with an air conditioner, remove the compressor mounting bracket bolts, and position the compressor out of the way. **Do not disconnect the compressor refrigerant lines.**

5. Loosen the alternator mounting bolts at the alternator. Remove the drive belt. Remove the alternator support bracket bolts at the water pump and move the brackets out of the way. Remove the water pump and fan assembly.

On a vehicle with air conditioning remove the condenser attaching bolts and position the condenser forward. **Do not disconnect the refrigerant lines.** Remove the compressor drive belt. On Thermactor engines remove the air supply pump drive belt. If so equipped, remove the accessory drive pulley.

6. Remove the cap screw and washer from the end of the crankshaft. On a vehicle with power steering remove the power steering pulley.



FIG. 24—Removing or Installing Timing Chain and Sprocket

from the crankshaft damper. Install the puller on the crankshaft damper (Fig. 22) and remove the damper.

7. Disconnect the carburetor fuel inlet line at the fuel pump.

8. Remove the fuel pump attaching bolts and lay the pump to one side with the flexible fuel line still attached.

9. Remove the crankshaft sleeve.

10. Remove the screws fastening the cylinder front cover to the block and to the oil pan. Using a thin blade knife cut the oil pan gasket flush with cylinder block face prior to separating the cover from the cylinder block. Remove the cylinder front cover.

11. Discard the cylinder front cover gasket. Remove the crankshaft front oil slinger.

12. Crank the engine until the timing marks on the sprockets are positioned as shown in Fig. 23.

13. Remove the camshaft sprocket cap screw and the fuel pump eccentric.

14. Slide both sprockets and the timing chain forward, and remove them as an assembly (Fig. 24).

#### FRONT OIL SEAL REPLACEMENT

It is good practice to replace the oil seal each time the cylinder front cover is removed.

1. Drive out the old seal with a pin punch. Clean out the recess in the cover.

2. Coat a new seal with grease, and install the seal. Drive the seal in until it is fully seated in the recess (Fig. 25). Check the seal after installation to be sure the spring is properly positioned in the seal.

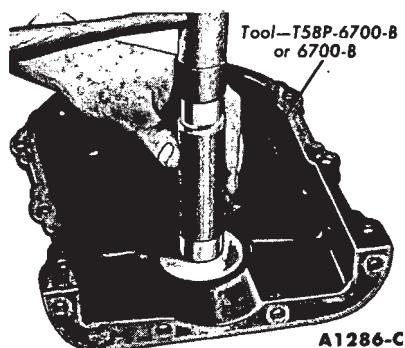


FIG. 25—Installing Oil Seal

#### INSTALLATION

1. Position the sprockets and timing chain on the camshaft and crankshaft (Fig. 24). Be sure the timing marks on the sprockets are positioned as shown in Fig. 23.

2. Install the fuel pump eccentric and the cam shaft sprocket cap screw to specifications. Install the crankshaft front oil slinger.

3. Clean all oil pan and cylinder block to front cover gasket surfaces.

4. Coat the gasket surface of the oil pan with sealer, cut and position the required section of a new gasket on the oil pan; apply sealer at the corners.

5. Coat the gasket surfaces of the block and cover with sealer, and position a new gasket on the block.

6. Position the cylinder front cover on the cylinder block. **Use care when installing the cover to avoid seal damage or possible gasket mislocation.**

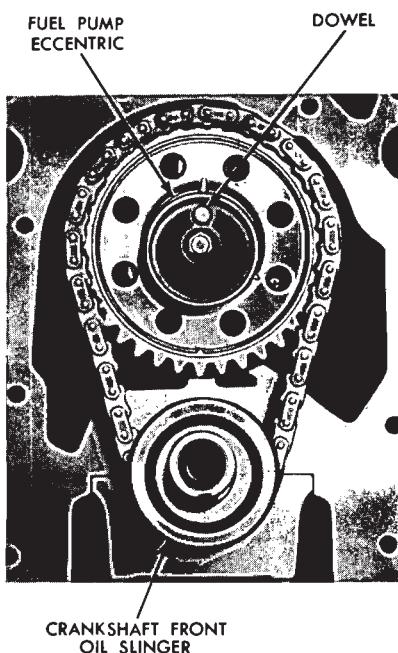
7. Install the cylinder front cover to seal alignment tool into proper position. It may be necessary to force the cover downward to slightly compress the pan gasket. This operation can be facilitated by using a suitable tool at the cover attaching screw hole locations in the cylinder block.

8. Coat the threads of the attaching bolts with oil-resistant sealer.

While pushing in on the pilot, install and torque the oil pan to cover attaching screws to specifications. Install and torque the oil pan to cover attaching screws to specifications. Install and torque the cover attaching screws to specification (Fig. 27). Remove the pilot.

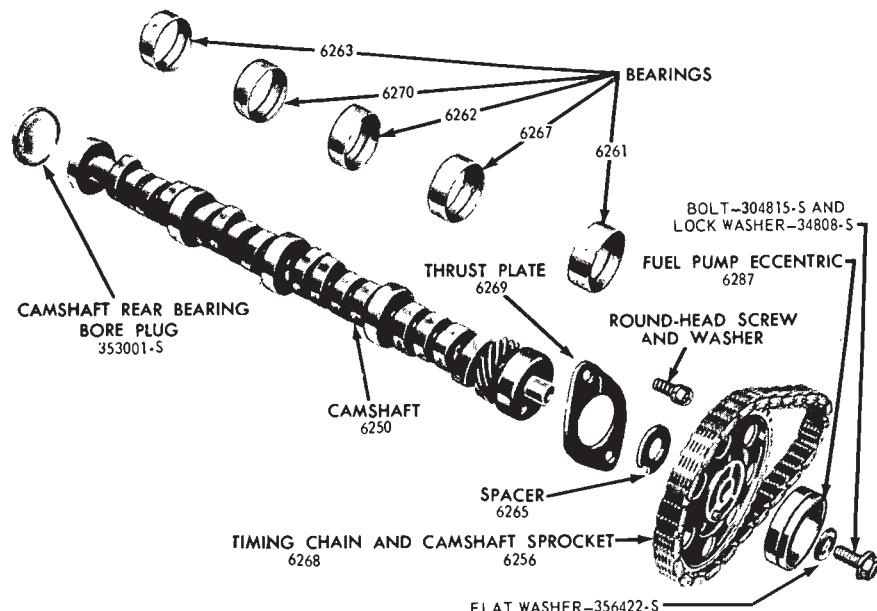
9. Lubricate the front seal contact surface of the sleeve with lubriplate and install the crankshaft sleeve.

10. Lubricate the inside diameter of the hub and line up the damper keyway with the key on the crankshaft. Install the damper on the



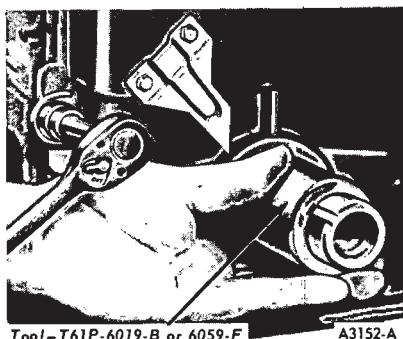
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**FIG. 26—Fuel Pump Eccentric  
and Front Oil Slinger Installed**

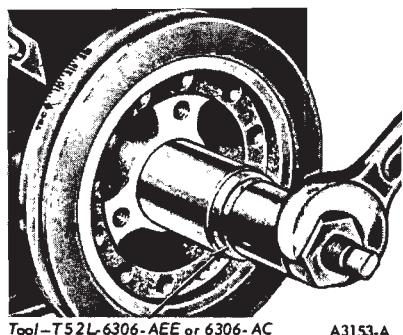


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**FIG. 29—Camshaft and Related Parts**



**FIG. 27—Aligning Cylinder Front Cover**



**FIG. 28—Installing Crankshaft Damper**

crankshaft (Fig. 28).

11. On a vehicle with power steering, install the power steering pump pulley on the damper. Torque the

screws to specifications. Install the damper cap screw and washer. Torque the screw to specifications.

12. Clean the water pump gasket surfaces. Coat new gaskets with water-resistant sealer and position the gaskets on the block. Install the water pump and fan, and torque the water pump mounting bolts to specifications. Attach the alternator adjusting arm and mounting bracket to the water pump.

13. Install and adjust the alternator drive belt(s) to the specified tension.

14. Install the fuel pump, using a new gasket. Connect the carburetor fuel inlet line, to the fuel pump and to the carburetor filter. Use new clamps.

15. On a vehicle with an air conditioner, install the compressor and adjust the drive belt. On Thermactor engines, install the air pump drive belt and adjust to specifications.

On a vehicle with power steering, install the power steering pump and drive belt. Adjust the drive belt tension to specification.

16. Connect the heater hoses. Slide the water pump bypass tube clamp forward on the tube.

17. Install the radiator. Connect the radiator lower hose at the water pump and the radiator upper hose at the thermostat housing. Connect the battery ground cable.

On a vehicle with an automatic transmission, connect the transmission oil cooler lines.

18. If any of the coolant entered

the oil pan when separating the cylinder front cover from the block, the crankcase oil should be drained and refilled with the proper grade and quantity of engine oil before starting the engine.

19. Fill and bleed the cooling system. Connect the heater hose to the intake manifold.

20. Operate the engine at fast idle and check for coolant and oil leaks. Adjust the ignition timing.

## CAMSHAFT

The camshaft and related parts are shown in Fig. 29.

## REMOVAL

1. Remove the cylinder front cover and the timing chain and sprockets following steps 1 thru 11 under Cylinder Front Cover and Timing Chain Removal. On Thermactor engines, disconnect the air hoses as necessary for accessibility, and position them out of the way.

2. Remove the grille. On a vehicle with air conditioning, remove the condenser attaching bolts, and position the condenser to one side. Do not disconnect the condenser refrigerant lines.

3. Refer to Valve Rocker Arm Shaft Assembly Removal, and remove the valve rocker arm covers and the valve rocker arm shaft assemblies.

4. Remove the intake manifold and

baffle plate, following the procedures under Intake Manifold Removal.

5. Remove the valve lifters and place them in a rack so they can be identified and installed in their original locations.

6. Remove the timing chain and sprockets following steps 12 thru 14 under Cylinder Front Cover and Timing Chain Removal.

7. Remove the camshaft thrust plate and spacer. Carefully remove the camshaft by pulling it toward the front of the engine. Use caution to avoid damaging the camshaft bearings.

## INSTALLATION

1. Oil the camshaft journals with heavy MS oil and apply Lubriplate to the lobes. Carefully slide the camshaft through the bearings. Install the thrust plate and spacer. The chamfered ID of the spacer must be toward the camshaft front journals. Be sure the thrust plate oil groove is up and towards the front (next to camshaft sprocket).

2. Check the camshaft end play. Install a dial indicator so the indicator point is on the camshaft sprocket attaching screw. Push the camshaft toward the rear of the engine and set the dial indicator on zero. Pull the camshaft forward and release it. Compare the indicator reading with the specifications. If the end play is excessive, check the spacer for correct installation. If the spacer is installed correctly, replace the thrust plate.

3. Position the sprockets and timing chain on the camshaft and crankshaft (Fig. 24) with the timing marks on the sprockets aligned as shown in Fig. 23.

4. Install the fuel pump eccentric and the camshaft sprocket cap screw (Fig. 26). Torque the sprocket cap screw to specifications. Install the front oil slinger.

5. Replace the crankshaft front oil seal. Install the cylinder front cover, crankshaft damper, and related parts following steps 3 thru 14 under Cylinder Front Cover and Timing Chain Installation.

6. Install the grille.

7. Install the valve lifters in the bores from which they were removed. Install the intake manifold, following the procedures under Intake Manifold Installation.

8. Install the push rods in their original positions. Refer to Valve Rocker Arm Shaft Assembly Installation, and install the valve rocker arm

shaft assembly following steps 1 thru 8.

On Thermactor engines connect the air hoses.

On a vehicle with air conditioning, position the condenser and install the attaching bolts. Install the radiator.

9. Fill and bleed the cooling system. Fill the crankcase with the proper grade and quantity of engine oil.

10. Start the engine and check and adjust the ignition timing. Connect the distributor vacuum hoses. Operate the engine at fast idle and check all hose connections and gaskets for leaks.

## CAMSHAFT REAR BEARING BORE PLUG REPLACEMENT

1. On a vehicle with a manual-shift transmission, slide the transmission to the rear and remove the clutch pressure plate, disc and flywheel housing following the procedure in Group 16.

On a vehicle with an automatic transmission, remove the transmission and converter housing following the procedure in Group 17.

2. Remove the flywheel attaching bolts and remove the flywheel. Remove the rear cover plate.

3. Replace the core plug as detailed in Part 21-01, Section 2.

4. Install the rear cover plate. Install the flywheel.

On a vehicle with a manual-shift transmission, install the clutch pressure plate disc, flywheel housing and

transmission following the procedure in Group 16.

On a vehicle with an automatic transmission, install the transmission and converter housing following the procedure in Group 17.

## HYDRAULIC VALVE LIFTER REPLACEMENT

The following procedure is applicable for removing one or all of the valve lifters. Before replacing a hydraulic valve lifter for noisy operation, be sure the noise is not caused by improper valve clearance or by worn rocker arms or push rods.

1. Refer to Valve Rocker Arm Shaft Assembly Removal, and remove the valve rocker arm covers and valve rocker arm shaft assemblies following steps 1 thru 5.

2. Position an inspection light to shine through the push rod opening and into the push rod valley (Fig. 30). Remove the lifters with a claw-type tool through the push rod openings. In some cases it will be necessary to transfer the lifter to an adjoining opening in order to remove it. Place the lifters in a rack so that they can be installed in their original positions.

The internal parts of each hydraulic valve lifter assembly are matched sets. Do not inter-mix the parts. Keep the assemblies intact until they are to be cleaned.

3. Install the new (or cleaned) hydraulic valve lifters through the push

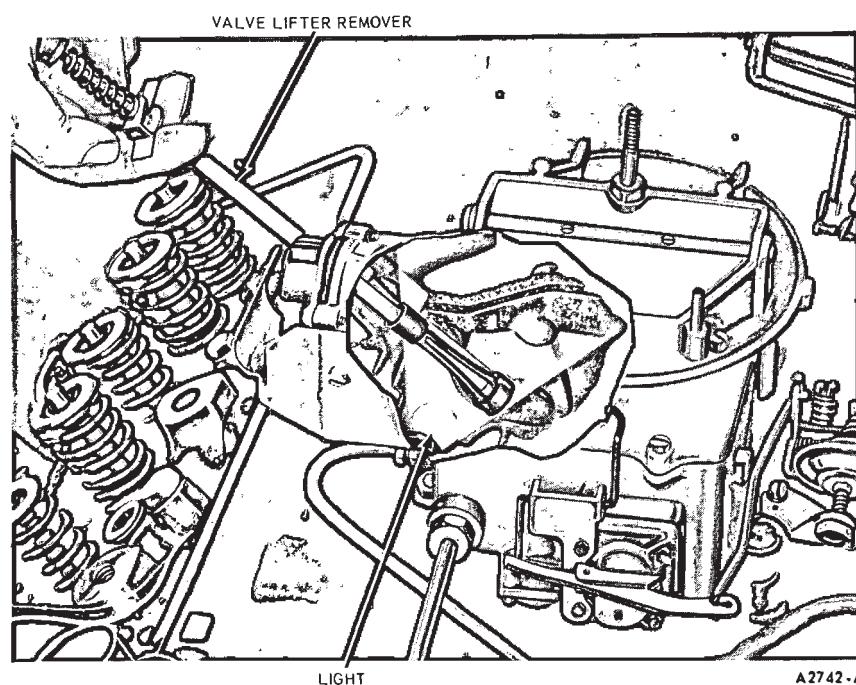
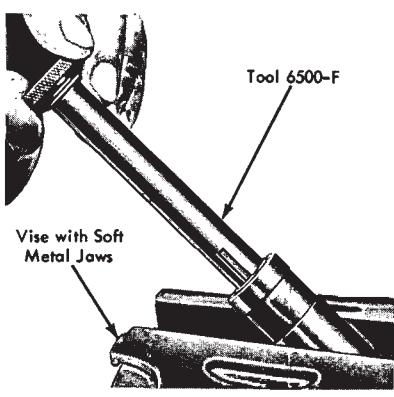
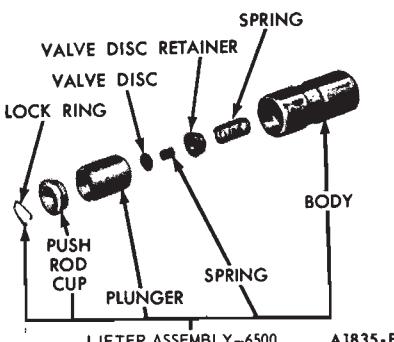


FIG. 30—Removing or Installing Valve Lifter Intake Manifold Installed



**FIG. 31—Removing Lifter Plunger**



**FIG. 32—Typical Hydraulic Valve Lifter Assembly**

rod openings with the lifter removal tool (Fig. 30). Install the push rods in their original positions.

4. Refer to Valve Rocker Arm Shaft Assembly Installation and install the valve rocker arm shaft assemblies and rocker arm covers by following steps 4 thru 8.

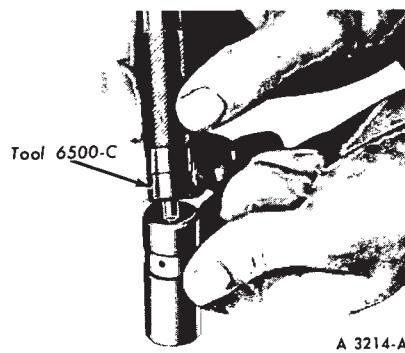
#### HYDRAULIC VALVE LIFTER DISASSEMBLY

Each valve lifter is a matched assembly. If the parts of one lifter are intermixed with those of another, improper valve operation may result. Disassemble and assemble each lifter separately. Keep the lifter assemblies in proper sequence so that they can be installed in their original bores.

1. Grasp the lock ring with the needle nose pliers to release it from the groove. It may be necessary to depress the plunger to fully release the lock ring.

2. Remove the push rod cup. Remove the plunger (Fig. 31) and plunger spring.

3. Invert the plunger assembly and



**FIG. 33—Installing Valve Lifter Lock Ring**

remove the disc valve retainer by carefully prying up on it with a screwdriver. Remove the disc valve and spring.

#### HYDRAULIC VALVE LIFTER ASSEMBLY

A typical hydraulic valve lifter assembly is shown in Fig. 32.

1. Place the plunger upside down on a clean work bench.

2. Place the disc valve in position over the oil hole on the bottom of the plunger. Set the disc valve spring on top of the disc.

3. Position the disc valve retainer over the disc and spring and push the retainer down into place on the plunger.

4. Place the plunger spring and then the plunger (open end up) into the lifter body.

5. Place the push rod cup in the plunger.

6. Push the plunger and push rod cup into the body and install the lock ring (Fig. 33). Release the plunger; then depress it again to fully seat the lock ring.

7. Use the hydraulic valve lifter leakdown tester (Part 21-01) to fill the lifters with test fluid.

#### VALVE CLEARANCE—HYDRAULIC VALVE LIFTERS

The valve arrangement is E-I-E-I-E-I-E from front to rear on both cylinder banks.

A 0.060-inch shorter push rod or a 0.060-inch longer push rod are available for service to provide a means of compensating for dimensional changes in the valve mechanism. Refer to the Master Parts List or the specifications for the pertinent color code.

Valve stem to valve rocker arm

clearance should be within specifications with the hydraulic lifter completely collapsed. Repeated valve reconditioning operations (valve and/or valve seat refacing) will decrease the clearance to the point that if not compensated for, the hydraulic valve lifter will cease to function and the valve will be held open.

To determine whether a shorter or a longer push rod is necessary, make the following check:

1. Disconnect the brown lead (I terminal) and the red and blue lead (S terminal) at the starter relay. Install an auxiliary starter switch between the battery and S terminals of the Starter relay. Crank the engine with the ignitions switch OFF until the No. 1 piston is on TDC after the compression stroke.

2. With the crankshaft in the positions designated in Steps 3 and 4, position the hydraulic lifter compressor tool (T58P-6565-A) on the rocker arm. Slowly apply pressure to bleed down the hydraulic lifter until the plunger is completely bottomed. Hold the lifter in this position and check the available clearance between the rocker arm and the valve stem tip with a feeler gauge.

If the clearance is less than specifications, install an under size push rod. If the clearance is greater than specifications, install an oversize push rod.

3. With the No. 1 piston on TDC at the end of the compression stroke, check the following valves:

No. 1 Intake No. 1 Exhaust  
No. 3 Intake No. 4 Exhaust  
No. 7 Intake No. 5 Exhaust  
No. 8 Intake No. 8 Exhaust

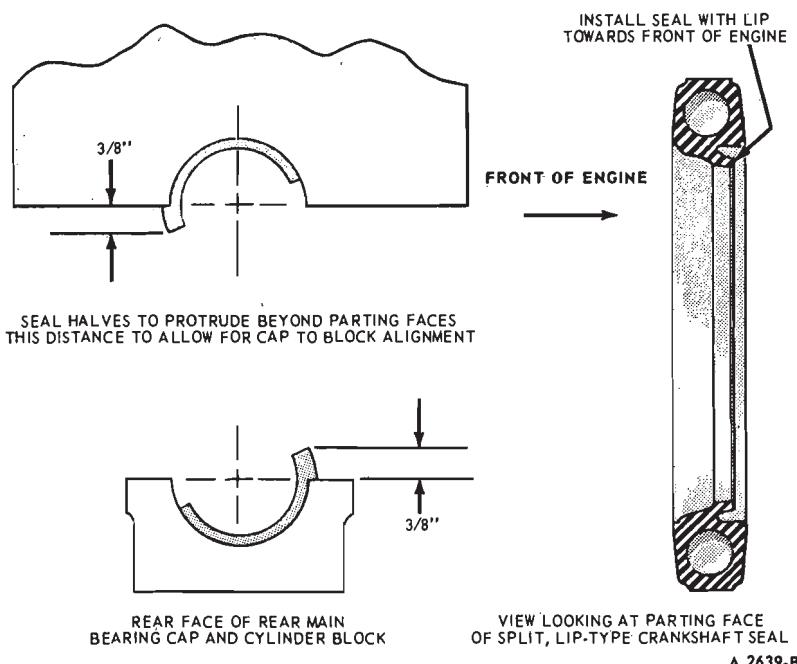
4. After these valves have been checked, rotate the crankshaft 360 degrees (one revolution) to position No. 6 piston on TDC and check the following valves:

No. 2 Intake No. 2 Exhaust  
No. 4 Intake No. 3 Exhaust  
No. 5 Intake No. 6 Exhaust  
No. 6 Intake No. 7 Exhaust

5. When compressing the valve spring to remove the push rods, be sure the piston in the individual cylinder is below TDC to avoid contact between the valve and the piston.

To replace a push rod, it will be necessary to remove the valve rocker arm shaft assembly, following the procedure in Parts 21-03 and 06.

Upon replacement of a valve push rod, valve rocker arm shaft assembly or hydraulic valve lifter, the engine should not be cranked or rotated until the hydraulic lifters have had an op-



**FIG. 34—Installing Crankshaft Rear Seal**

portunity to leak down to their normal operating position. The leak-down rate can be accelerated by using the compressor tool (T58P-6565-A) on the valve rocker arm and applying pressure in a direction to collapse the lifter.

#### CRANKSHAFT REAR OIL SEAL REPLACEMENT—SPLIT LIP TYPE

Replacement of a crankshaft rear oil seal to correct for oil leaks requires replacement of both the upper and lower seals, as follows:

1. Remove the oil pan and oil pump (as required) following the procedures in this section.

2. Loosen all the main bearing cap bolts, thereby lowering the crankshaft slightly but not to exceed  $1/32$  inch.

3. Remove the rear main bearing cap, and remove the oil seal from the bearing cap and cylinder block. On the block half of the seal use a seal removal tool, or install a small metal screw in one end of the seal, and pull on the screw to remove the seal. Exercise caution to prevent scratching or damaging the crankshaft seal surfaces.

4. Carefully clean the seal grooves in the cap and block with a brush and solvent.

5. Dip the split, lip-type seal halves in clean engine oil.

6. Carefully install the upper seal (cylinder block) into its groove with

undercut side of seal toward the FRONT of the engine (Fig. 34), by rotating it on the seal journal of the crankshaft until approximately  $3/8$  inch protrudes below the parting surface.

**Be sure no rubber has been shaved from the outside diameter of the seal by the bottom edge of the groove.**

7. Tighten the remaining bearing cap bolts and torque to specifications.

8. Install the lower seal in the rear main bearing cap with undercut side of seal toward the FRONT of the engine (Fig. 34), allow the seal to protrude approximately  $3/8$  inch above the parting surface to mate with the upper seal when the cap is installed.

9. Apply a thin coating of oil-resistant sealer to the rear main bearing cap at the rear of the top mating surface. **Do not apply sealer to the area forward of the side seal groove.** Install the rear main bearing cap. Torque the cap bolts to specifications.

10. Dip the side seals in light engine oil; then immediately install them in the grooves. Do not use sealer on the side seals. The seals are designed to expand when dipped in oil. Using sealer may retard this expansion. It may be necessary to tap the seals into place for the last  $1/2$  inch of travel. Do not cut the seal projecting ends.

11. Check the retainer side seals for leaks by squirting a few drops of oil into the parting lines between the rear main bearing cap and the cylinder block.

der block from the outside. Blow compressed air against the seals from the inside of the block. If air bubbles appear in the oil, it indicates possible oil leakage. This test should not be performed on newly installed seals until sufficient time has been allowed for the seals to expand into the seal grooves.

12. Install the oil pump and oil pan. Install the oil level dipstick. Fill the crankcase with the proper amount and viscosity oil.

13. Operate the engine and check for oil leaks.

#### MAIN AND CONNECTING ROD BEARING REPLACEMENT

The main and connecting rod bearing inserts are selective fit. Do not file or lap bearing caps or use shims to obtain the proper bearing clearance.

Selective fit bearings are available for service in standard size 0.001 and 0.002 inch undersize. A standard bearing may be used in the cylinder block with a 0.001 or 0.002 inch bearing in the bearing cap to reduce or obtain the proper clearance. Refer to the Parts Catalog for the available sizes. Undersize bearings, which are not selective fit, are available for use on journals that have been refinished.

#### MAIN BEARING REPLACEMENT

1. Drain the crankcase. Remove the oil level dipstick. Remove the oil pan and oil pump. Remove the spark plugs to allow easy rotation of the crankshaft.

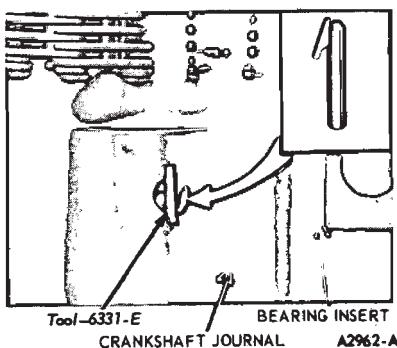
2. Replace one bearing at a time, leaving the other bearing securely fastened. Remove the main bearing cap to which new bearings are to be installed.

3. Insert the upper bearing removal tool (tool 6331-E) in the oil hole in the crankshaft (Fig. 35).

4. Rotate the crankshaft in the direction of engine rotation to force the bearing out of the block.

5. Clean the crankshaft journal and bearing inserts. When replacing standard bearings with new bearings, it is good practice to try to obtain the proper clearances with a standard and 0.001 or 0.002 inch undersize bearing halves.

6. To install the upper main bearing, place the plain end of the bearing over the shaft on the locking tang side of the block and partially install the bearing so that tool 6331-E can be inserted in the oil hole in the crankshaft



**FIG. 35—Removing or Installing Upper Main Bearing Insert**

(Fig. 35). With tool 6331-E positioned in the oil hole in the crankshaft, rotate the crankshaft in the opposite direction of engine rotation until the bearing seats itself. Remove the tool.

7. Install the lower bearing in the cap. Select-fit the bearing for proper clearance following procedures given under Fitting Main and Connecting Rod Bearings in Part 21-01.

8. If Plastigage indicates the clearance is less than the specified limits, try a combination of standard and undersize bearings. If the clearance exceeds specified service limits, try 0.002 inch undersize bearings in combination with a standard bearing. The bearing clearance must be within specified service limits. Whenever a combination of undersize bearings with standard bearings is used, the undersize bearing should go in the top, or block. If the standard and 0.002 inch undersize bearings do not bring the clearance within the desired limits, refinish the crankshaft journal (Refer to Part 21-01, Section 02). Then install undersize bearings.

9. After the bearing has been checked and found to be satisfactory, apply a light coat of heavy MS engine oil to the journal and bearings; then install the bearing cap. Torque the cap bolts to specifications.

10. If the thrust bearing cap (No. 3 main bearing) has been removed, install it as follows:

Install the thrust bearing cap with the bolts finger-tight. Pry the crankshaft forward against the thrust surface of the upper half of the bearing. Hold the crankshaft forward and pry the thrust bearing cap to the rear. This will align thrust surfaces of both halves of the bearing. Retain the forward pressure on the crankshaft. Torque the cap bolts to specifications.

11. Repeat the procedure for the remaining bearings that require replacement.

12. If the rear main bearing is to be replaced, remove the rear main bearing cap. Remove and discard the rear seal and side seals.

13. Clean the rear journal oil seal grooves in the block and cap.

14. Install a new rear oil seal in the rear main bearing cap and block, following the procedures under Crankshaft Rear Oil Seal Replacement.

15. Apply a thin coating of oil resistant sealer to the rear main bearing cap at the rear of the top mating surface. **Do not apply sealer to the area forward of the side seal groove.** Install the rear main bearing cap. Torque the cap bolts to specifications.

16. Dip the side seals in light engine oil; then immediately install them in the grooves. **Do not use sealer on the side seals.** The seals are designed to expand when dipped in oil. Using sealer may retard this expansion. It may be necessary to tap the seals into place for the last 1/2 inch of travel. Do not cut the seal projecting ends.

17. Check the retainer side seals for leaks by squirting a few drops of oil into the parting lines between the rear main bearing cap and the cylinder block from the outside. Blow compressed air against the seals from the inside of the block. If air bubbles appear in the oil, it indicates possible oil leakage. **This test should not be performed on newly installed seals until sufficient time has been allowed for the seals to expand into the seal grooves.**

18. Disassemble, clean and assemble the oil pump if necessary (Refer to Part 21-01, Section 3). Prime the oil pump by filling the inlet opening with oil and rotate the pump shaft until oil emerges from the outlet opening. Install the oil pump and oil pan.

19. Install the oil level dipstick. Fill the crankcase with the proper amount and viscosity oil. Install the spark plugs.

20. Operate the engine and check for oil leaks.

#### CONNECTING ROD BEARING REPLACEMENT

1. Follow step 1 under Main Bearing Replacement.

2. Turn the crankshaft until the connecting rod to which new bearings are to be fitted is down.

3. Remove the connecting rod cap. Push the connecting rod up into the cylinder and remove the bearing in-

sert from the rod and cap.

4. Follow step 5 under Main Bearing Replacement.

5. Install the new bearings in the connecting rod and cap. Pull the connecting rod assembly down firmly on the crankshaft journal. Select-fit the bearing for proper clearance following procedures given under Fitting Main and Connecting Rod Bearings in Part 21-01.

6. If the clearance is less than the specified limits, try an undersize bearing half in combination with a standard bearing half.

**The bearing clearance must be within specified service limits.**

If the proper clearance cannot be achieved with a standard in combination with an 0.002 undersize bearing, the crankshaft will have to be ground undersize and fitted with undersize bearings (Refer to Part 21-01, Section 2).

7. After the bearing clearance has been checked and found to be satisfactory, apply a light coat of engine oil to the journal and bearings. Install the connecting rod cap.

8. Repeat the procedure for the remaining connecting rods that require new bearings.

9. Follow step 21, 22 and 23 under Main Bearing Replacement.

#### PISTON AND CONNECTING ROD ASSEMBLY

##### REMOVAL

1. Drain the cooling system and the crankcase. Remove the intake manifold, cylinder heads, oil pan and oil pump following the procedures in this section.

2. Remove any ridge and/or deposits from the upper end of the cylinder bores as follows:

Turn the crankshaft until the piston to be removed is at the bottom of its travel and place a cloth on the top of piston to collect the cuttings. Remove any ridge and/or deposits from the upper end of the cylinder bores. Remove the cylinder ridge with a ridge cutter (tool 6011-E). Follow the instructions furnished by the tool manufacturer. Never cut into the ring travel area in excess of 1/32 inch when removing ridges.

3. Make sure all connecting rod caps are marked so that they can be installed in their original locations.

4. Turn the crankshaft until the connecting rod being removed is down.

5. Remove the connecting rod cap.

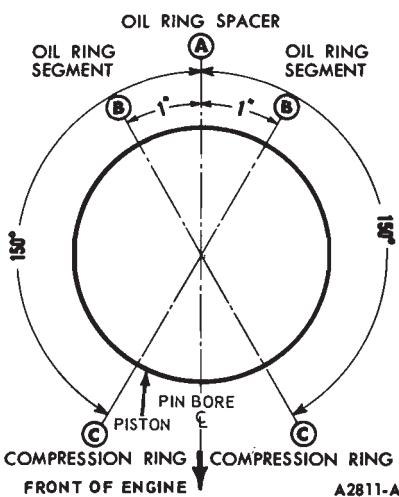
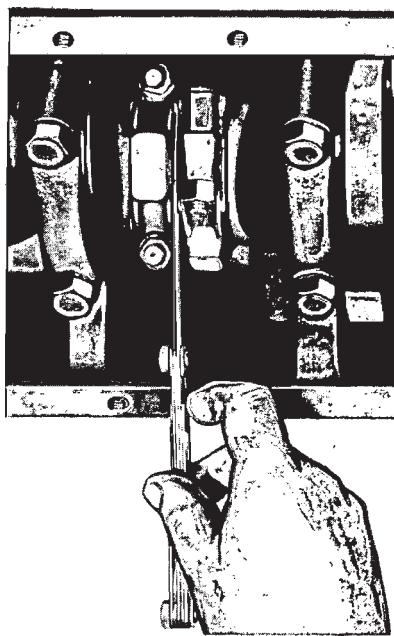


FIG. 36—Piston Ring Gap Spacing



A3155-A

FIG. 38—Checking Connecting Rod Side Clearance

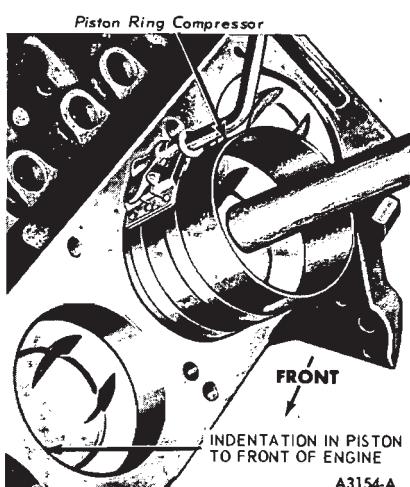


FIG. 37—Typical Piston Installation

6. Push the connecting rod and piston assembly out of the top of the cylinder with the handle end of a hammer. Avoid damage to the crankshaft journal or the cylinder wall when removing the piston and rod.

7. Remove the bearing inserts from the connecting rod and cap.

8. Install the cap on the connecting rod from which it was removed.

#### INSTALLATION

1. If new piston rings are to be installed, remove the cylinder wall glaze (Part 21-01, Section 2, Repairs-

Cylinder Block). Follow the instructions of the tool manufacturer. After performing cylinder bore repairs, clean the bore(s), following the procedure in Part 21-01, Section 3.

2. Oil the piston rings, pistons and cylinder walls with light engine oil. Be sure to install the pistons in the same cylinders from which they were removed or to which they were fitted. The connecting rod and bearing cap are numbered from 1 to 4 in the right bank and from 5 to 8 in the left bank, beginning at the front of the engine. The numbers on the connecting rod and bearing cap must be on the same side when installed in the cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and the connecting rod should be numbered to correspond with the new cylinder number.

3. Make sure the ring gaps are properly spaced around the circumference of the piston (Fig. 36).

4. Oil the piston rings generously. Then install a piston ring compressor on the piston and push the piston in with a hammer handle until it is slightly below the top of the cylinder (Fig. 37). Be sure to guide the connecting rods to avoid damaging the crankshaft journals. Install the piston with the indentation in the piston head toward the front of the engine.

5. Check the clearance of each bearing following the procedure under

#### Connecting Rod Bearing Replacement

6. After the bearings have been fitted, apply a light coat of engine oil to the journals and bearings.

7. Turn the crankshaft throw to the bottom of its stroke. Push the piston all the way down until the connecting rod bearing seats on the crankshaft journal.

8. Install the connecting rod cap. Torque the nuts to specifications.

9. After the piston and connecting rod assemblies have been installed, check the side clearance between the connecting rods on each crankshaft journal (Fig. 38).

10. Disassemble, clean and assemble the oil pump. Clean the oil pump inlet tube screen and the oil pan and cylinder block gasket surfaces.

11. Prime the oil pump by filling the inlet opening with oil and rotating the pump shaft until oil emerges from the outlet opening. Install the oil pump and pan.

12. Install the cylinder heads by following step 1 thru 6 under Cylinder Head Installation.

13. Refer to Intake Manifold Installation and install the intake manifold by following steps 2 thru 18.

14. Fill and bleed the cooling system. Fill the crankcase with the proper grade and quantity of engine oil.

15. Install the automatic choke heat chamber air inlet tube. Install the air cleaner. Operate the engine and check for oil and coolant leaks. Check and adjust the ignition timing.

16. Adjust the engine idle speed and fuel mixture. Refer to Part 23-01, Section 2.

#### DISASSEMBLY

1. Mark the pistons and pins to assure assembly with the same rod and installation in the same cylinder from which they were removed.

2. Remove the piston rings. Remove the piston pin retainers. Drive the pin out of the piston and connecting rod (Fig. 39). Discard the retainers.

#### ASSEMBLY

The piston, connecting rod and related parts are shown in Fig. 40.

1. Lubricate all parts with light engine oil. Position the connecting rod in the piston and push the pin into place. Assemble the piston and connecting rod as shown in Fig. 41.

2. Insert new piston pin retainers

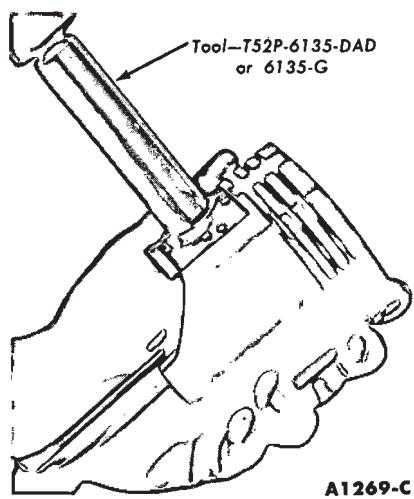


FIG. 39—Removing Piston Pin

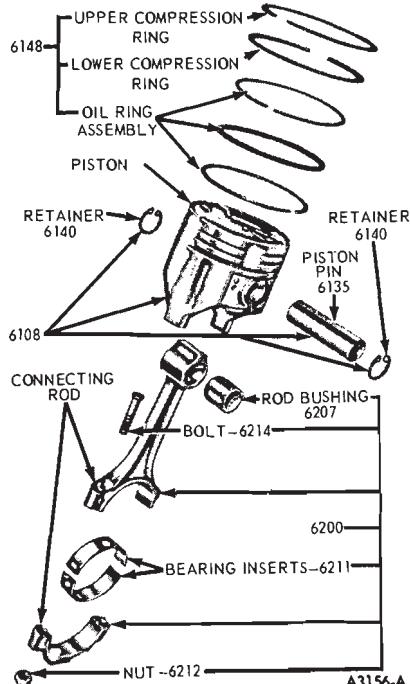


FIG. 40—Piston, Connecting Rod and Related Parts

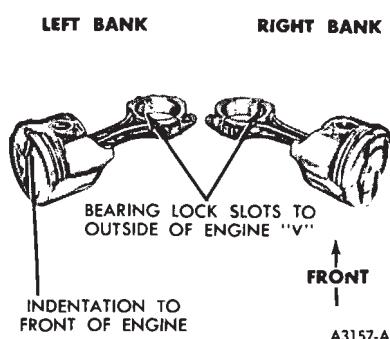


FIG. 41—Correct Piston and Connecting Rod Position

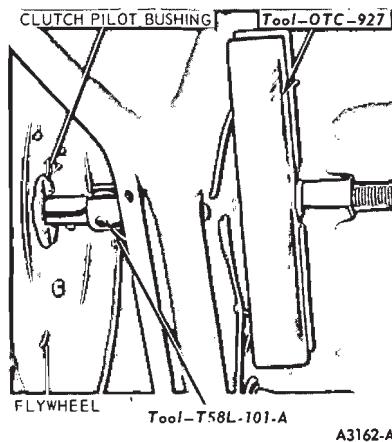


FIG. 42—Removing Clutch Pilot Bushing

into the piston. Check the end gap of all piston rings (Part 21-01). It must be within specifications. Follow the instructions contained on the piston ring package and install the piston rings. Be sure the piston ring gaps are properly spaced (Fig. 36).

3. Check the ring side clearance of the compression rings with a feeler gauge (Refer to Fitting Piston Rings in Part 21-01, Section 2).

4. Be sure the bearing inserts and the bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause a failure. Install the bearing inserts in the connecting rod and cap with the tangs fitting in the slots provided.

### Section 1.

3. On a manual-shift transmission, install the pressure plate and cover assembly (Group 16).

4. Connect the transmission to the engine as outlined in Group 16 (manual-shift transmissions), or on an automatic transmission, install the transmission (Group 17). It is not necessary to adjust the transmission, when it has been removed only for flywheel removal.

### CLUTCH PILOT BUSHING REPLACEMENT

Inspection procedures are outlined under Crankshaft Cleaning and Inspection in Part 21-01, Section 3.

1. Disconnect the transmission from the engine and slide it to the rear as outlined in Group 16.

2. Remove the pressure plate and cover assembly and the clutch disc as outlined in Group 16.

3. Remove the pilot bushing (Fig. 42).

4. Coat the pilot bushing bore in the crankshaft with a small quantity of wheel bearing lubricant. Avoid using too much lubricant as it may be thrown onto the clutch disc when the clutch revolves.

5. Install the pilot service bearing (Fig. 43).

6. Install the clutch disc and the pressure plate and cover assembly as outlined in Group 16.

7. Connect the transmission to the engine as outlined in Group 16.

### OIL FILTER REPLACEMENT

The Autolite oil filter assembly is shown in Fig. 44.

1. Place a drip pan under the filter. Unscrew the filter from the adapter fitting. Clean the adapter filter recess.

2. Coat the gasket on the new filter with oil. Place the filter in position on the adapter (Fig. 45). Hand tighten the filter until the gasket contacts the adapter face. Then advance it  $1/2$  turn.

3. Operate the engine at fast idle and check for leaks. If oil leaks are evident, perform the necessary repairs to correct the leakage. Check the oil level and fill the crankcase if necessary.

### OIL PAN

#### REMOVAL

1. Raise the vehicle and place safety stands into position. Drain the oil

### FLYWHEEL

#### REMOVAL

1. Disconnect the transmission from the engine and slide it to the rear as outlined in Group 16 (manual-shift transmission), or on an automatic transmission remove the transmission (Group 17).

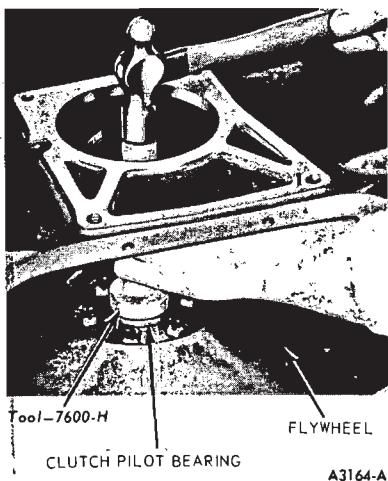
On a manual-shift transmission, remove the pressure plate and cover assembly as outlined in Group 16.

2. Remove the flywheel attaching bolts and remove the flywheel.

#### INSTALLATION

1. Install the flywheel on the crankshaft flange and install the attaching bolts. Torque the bolts to specifications, in sequence (across from each other).

2. Check the flywheel runout, following the procedure in Part 21-01,



**FIG. 43—Installing Clutch Pilot Bearing**



**FIG. 44—Oil Filter Assembly**

frame cross-member. Remove the floor jack.

4. Remove the oil pan attaching screws and lower the oil pan to the frame cross member.

5. Crank the engine to obtain the necessary clearance between the crankshaft counterweight and the rear of the oil pan. Remove the upper bolt and loosen the lower bolt on the inlet tube (Fig. 46). Position the inlet tube and screen out of the way, and remove the oil pan.

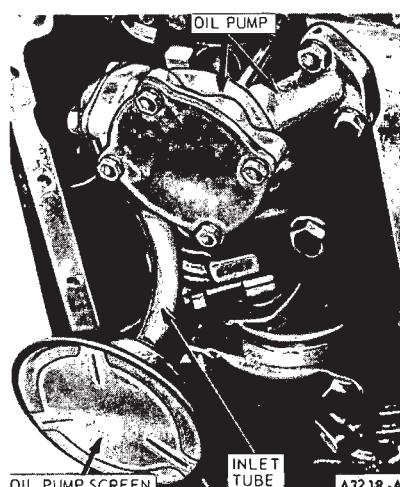
## INSTALLATION

1. Clean the oil pan and cylinder block gasket surfaces following the procedures in Part 21-01. Clean the oil pump inlet tube screen. Position a new oil pump inlet tube gasket on the oil pump and install the inlet tube (Fig. 46) with the lower bolt only. Do not tighten the bolt.

2. Apply oil-resistant sealer to the oil pan gasket surfaces and position the gasket on the oil pan.

3. Position the oil pan on the crossmember and install the inlet tube to oil pump upper mounting bolt. Tighten both bolts.

4. Hold the oil pan in place against the cylinder block and install an attaching screw on each side of the pan. Using the special spring washers, install the oil pan to rear main bearing cap bolts. Install the remaining screws and tighten them from the center outward. Torque the screws to



**FIG. 45—Replacing Oil Filter**

specifications.

5. Position the floor jack and block of wood under the leading edge of the oil pan. Raise the engine slightly and remove the wood blocks from beneath the insulators. Lower the engine and remove the jack. Install the insulator to frame lock washers and nuts. Torque the nuts to specifications.

6. Connect the stabilizer bar. Replace the oil filter. Remove the safety stands and lower the vehicle. If the fan shroud was removed, install it on the radiator.

7. Fill the crankcase with the proper grade and quantity of engine oil. Operate the engine and check for oil leaks.

## OIL PUMP

### REMOVAL

1. Remove the oil pan (refer to Oil Pan Removal).

2. Remove the oil pump attaching screws; then remove the oil pump and intermediate drive shaft.

3. Remove the inlet tube and screen assembly from the oil pump. Discard the gasket.

### INSTALLATION

1. Prime the oil pump by filling either the inlet or outlet port with engine oil. Rotate the pump shaft to distribute the oil within the pump body.

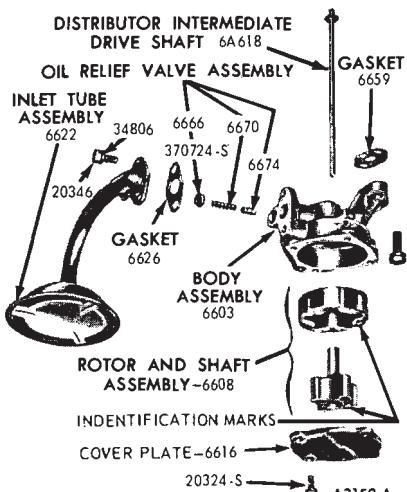
2. Position a new gasket on the pump housing. Insert the intermediate drive shaft into the oil pump. Install the pump and shaft as an assembly (Fig. 46). Do not attempt to force the pump into position if it will not seat

**FIG. 46—Oil Pump and Inlet Tube Installed**

from the crankcase. On a vehicle equipped with air conditioning, remove the fan shroud from the radiator and position it over the fan.

2. Disconnect the stabilizer bar at the connecting links and pull the ends down.

3. To allow clearance for removal of the oil pan, remove the engine front support insulator to intermediate support bracket nuts and lock washers. Install a block of wood on a floor jack and position the jack under the front leading edge of the oil pan. Raise the engine approximately 1-1/4 inches and insert a 1 inch block of wood between the insulators and the



**G. 47—Oil Pump Disassembled**

readily. The drive shaft hex may be misaligned with the distributor shaft.

To align, rotate the intermediate shaft into a new position. Torque the oil pump attaching screws to specifications.

3. Install the inlet tube and screen assembly and oil pan, following the procedure under Oil Pan Installation.

#### DISASSEMBLY

1. Remove the oil inlet tube from the oil pump and remove the gasket.

2. Remove the cover attaching screws, then remove the cover. Remove the inner rotor and shaft assembly and the outer race.

3. Remove the staking marks at the relief valve chamber cap. Insert a self-threading sheet metal screw of the proper diameter into the oil pressure relief valve chamber cap and pull the cap out of the chamber. Remove the spring and plunger.

#### ASSEMBLY

The oil pump assembly is shown in Fig. 47.

1. Oil all parts thoroughly.  
2. Install the oil pressure relief valve plunger, spring and a new cap. Stake the cap.

3. Install the outer race and the inner rotor and shaft assembly. Be sure the dimple (identification mark) on the outer race is facing outward and on same side as identification mark on rotor. The inner rotor and shaft and the outer race are serviced as an assembly. One part should not be replaced without replacing the other. Install the cover. Torque the cover attaching screws to specifications.

4. Position a new gasket and the oil inlet tube on the oil pump and install the attaching bolts.

### 3 ENGINE REMOVAL AND INSTALLATION

The engine removal and installation procedures are for the engine only without the transmission attached.

#### 390 AND 428 V-8

##### REMOVAL

1. Drain the cooling system and the crankcase. Remove the hood. Remove the air cleaner and disconnect the battery positive cable.

2. Disconnect the radiator upper hose at the engine and the radiator lower hose at the water pump. On a vehicle with automatic transmission disconnect the transmission oil cooler lines from the radiator.

3. Remove the cooling fan and spacer (or fan drive clutch) and power steering pump drive belt (if so equipped). Remove the radiator. Remove the oil level dipstick.

4. Disconnect the oil pressure sending unit wire at the sending unit and the flexible fuel line at the fuel tank line.

Disconnect the accelerator cable at the carburetor. Remove the accelerator retracting spring. Remove the accelerator cable bracket from the intake manifold. Position the accelerator cable and body ground strap out of the way.

On a vehicle with automatic trans-

mission, disconnect the kickdown rod at the carburetor. Remove the kickdown rod retracting spring. Disconnect the transmission vacuum line at the engine.

On a vehicle with power steering, remove the power steering pump from the mounting bracket. Remove the power steering hose bracket bolt. Wire the power steering pump in a position that will prevent the fluid from draining out. Remove the power steering pump bracket, coil bracket, and compressor bracket and compressor assembly (if equipped with air conditioning). Remove the coil. Position the compressor (with lines attached) out of the way. On a vehicle with power brakes, disconnect the brake vacuum hose at the pipe and position the hose out of the way.

5. Disconnect the heater hoses at the water pump and intake manifold and remove the heater hose from the automatic choke bracket. Disconnect the coolant temperature sending unit at the sending unit. Remove the wire loom from the clips on the left valve rocker arm cover and position it out of the way.

On a vehicle with air conditioning, remove the compressor from the mounting bracket, and position it out of the way, leaving the refrigerant lines attached.

6. Remove the battery ground cable and alternator ground cable bolt at the engine. Remove the alternator mounting bolts and spacer, and position the alternator out of the way.

7. Disconnect the fuel inlet line at the pump.

8. Raise the front of the vehicle. Remove the starter.

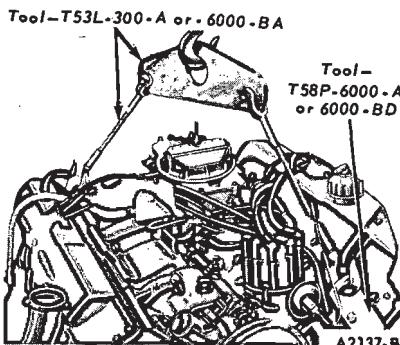
9. Disconnect the muffler inlet pipes from the exhaust manifolds.

10. Remove the engine support insulator to intermediate support bracket nuts, and loosen the right side support insulator to engine bolts.

On a vehicle with an automatic transmission, remove the flywheel housing cover. Remove the oil cooler lines retaining clip from the engine block. Disconnect the converter from the flywheel. Secure the converter assembly in the housing. Remove the remaining flywheel housing to engine bolts, and remove the transmission fluid filler tube bracket.

On a vehicle with a manual-shift transmission, remove the flywheel housing inspection cover and the clutch pedal retracting spring. Disconnect the clutch release bracket at the equalizer rod and remove the bracket from the engine. Remove the remaining flywheel housing to engine bolts.

11. Lower the vehicle; then support the transmission. Install the engine



**FIG. 48—Typical Engine Lifting Bracket and Sling**

left lifting bracket on the front of the left cylinder head, and install the engine right lifting bracket at the rear of the right cylinder head. Then attach the engine lifting sling (Fig. 48).

**12.** Remove the flywheel or converter housing to engine upper bolts.

**13.** Raise the engine slightly and carefully pull it from the transmission. Lift the engine out of the engine compartment.

#### INSTALLATION

**1.** Attach the engine lifting brackets and sling (Fig. 48).

**2.** Lower the engine carefully into the engine compartment. Make sure the exhaust manifolds are properly aligned with the muffler inlet pipes and the dowels in the block engage the holes in the flywheel housing.

On a vehicle with an automatic transmission, start the converter pilot into the crankshaft.

On a vehicle with a manual-shift transmission, start the transmission main drive gear into the clutch disc. It may be necessary to adjust the position of the transmission in relation to the engine if the input shaft will not enter the clutch disc. **If the engine hangs up after the shaft enters, turn the crankshaft slowly (transmission in gear) until the shaft splines mesh with the clutch disc splines.**

**3.** Install the flywheel or converter housing upper bolts.

**4.** Remove the transmission jack. Lower the engine until the front support insulators are properly positioned in the intermediate support brackets. Torque the right side insulator bolts to specifications. Disconnect the engine lifting sling and remove the lifting brackets.

**5.** Raise the vehicle and install the remaining flywheel housing to cylinder block attaching bolts. Torque the bolts to specifications.

**6.** Install the lock washers and nuts on the engine support insulators. Torque both insulator nuts to specifications.

**7.** Install new muffler inlet pipe gaskets, and connect the muffler inlet pipes to the exhaust manifolds. Torque the nuts to specifications.

**8.** On a vehicle with an automatic transmission, remove the retainer securing the converter in the housing. Attach the converter to the flywheel. Install the transmission fluid filler tube bracket. Install the flywheel housing cover assembly. Install the oil cooler lines bracket. Connect the kickdown rod to the transmission.

On a vehicle with a manual-shift transmission, install the clutch bracket. Connect the clutch release rod and install the clutch retracting spring. Install the flywheel housing lower cover.

**9.** Install the starter and transmission filler tube bracket. Attach the starter cable.

**10.** Lower the vehicle. Install the power steering pump bracket, coil bracket, and compressor and bracket assembly (if equipped with air conditioning).

**11.** Connect the flexible fuel line and the oil pressure sending unit wire.

**12.** Place the alternator drive belt on the crankshaft pulley. Install the power steering pump and adjust the belt tension to specifications. On a vehicle with air conditioning, install the compressor on the mounting bracket, and adjust the belt tension to specifications.

**13.** Install the alternator and attach the battery ground cable. Connect the alternator wires and coolant temperature sending unit wire. Connect the heater hoses at the water pump and intake manifold.

**14.** Install the ignition coil and connect the coil primary and high tension wires. Position the wire loom in the retaining clips on the left valve rocker arm cover. Install the oil level dipstick.

**15.** On a vehicle with an automatic transmission, connect the kickdown rod to the carburetor. Install the kickdown rod retracting spring. Connect the transmission vacuum line.

Install the accelerator cable bracket and body ground strap. Connect the accelerator cable to the carburetor and install the retracting spring.

**16.** Install the radiator. Connect the radiator upper and lower hoses. Install the hood.

On a vehicle with an automatic transmission, connect the transmission oil cooler lines.

**17.** Install the fan and spacer (or fan drive clutch). Torque the bolts to specifications. Position the alternator drive belt and adjust the tension to specifications. Tighten the alternator mounting bolts to specifications. Connect the battery positive cable.

On a vehicle with air conditioning, adjust the compressor belt tension to specifications.

**18.** Fill and bleed the cooling system. Connect the heater hose at the water pump. Fill the crankcase with the proper grade and quantity of oil. Install the hood.

**19.** Install the air cleaner and operate the engine at fast idle, checking all gaskets and hose connections for leaks.

**20.** Adjust the accelerator cable and the idle speed and fuel mixture following the procedure in Part 23-01.

On a vehicle with an automatic transmission, adjust the transmission control linkage.

#### 428 CJ

##### REMOVAL

**1.** Drain the cooling system and the crankcase. Remove the hood and the air cleaner. Disconnect the battery ground cable.

**2.** Disconnect the radiator upper hose at the engine and the radiator lower hose at the water pump. Disconnect the transmission oil cooler lines from the radiator.

**3.** Remove the radiator. Remove the oil level dipstick. Remove the cooling fan and spacer and power steering drive belt (if so equipped).

**4.** Disconnect the oil pressure sending unit wire at the sending unit, and the flexible fuel line at the fuel tank line. Plug the fuel tank line.

**5.** Disconnect the accelerator rod at the carburetor. Remove the accelerator retracting spring.

Disconnect the automatic transmission kickdown rod at the carburetor. Remove the kickdown rod retracting spring. Disconnect the transmission vacuum line at the engine.

On a vehicle with power steering, remove the power steering pump from the mounting bracket. Remove the power steering hose bracket bolt. Wire the power steering pump in a position that will prevent the oil from draining out. Remove the power steering pump bracket, coil bracket, and compressor bracket and compressor assembly (if equipped with air conditioning). Remove the coil. Position the compressor with lines at-

tached out of the way. On a vehicle with power brakes, disconnect the brake vacuum hose at the pipe and position the hose out of the way.

On a vehicle with air conditioning, remove the compressor from the mounting bracket, and position it out of the way, leaving the refrigerant lines attached.

6. Disconnect the heater hoses at the water pump and intake manifold, the alternator wires at the alternator, and the water temperature sending unit at the sending unit.

7. Disconnect the wire loom at the distributor and ignition coil. Remove the wire loom from the clips on the left valve rocker arm cover and position it out of the way.

8. Raise the front of the vehicle. Disconnect the muffler inlet pipe at the right exhaust manifold. Remove the exhaust control valve.

9. Disconnect the engine front support insulators at the frame. Raise the engine approximately 1 or 2 inches to provide necessary clearance to remove the right exhaust manifold.

10. Remove the right exhaust manifold. Disconnect the muffler inlet pipe at the left exhaust manifold.

11. Disconnect the starter cable. Remove the starter.

12. Remove the flywheel housing cover. Remove the oil cooler lines retaining clip from the engine block. Disconnect the converter from the flywheel. Secure the converter assembly in the housing. Remove the remaining flywheel housing to engine bolts, and remove the transmission fluid filler tube bracket.

13. Lower the vehicle and support the transmission. Install the engine left lifting bracket on the front of the left cylinder head, and install the engine right lifting bracket at the rear of the right cylinder head, then attach the engine lifting sling (Fig. 48).

14. Remove the converter housing to engine upper bolts.

15. Raise the engine slightly and carefully pull it from the transmission. Lift the engine out of the engine compartment.

## INSTALLATION

1. Clean the muffler inlet pipe gasket surfaces and both sides of the ex-

haust control valve assembly.

2. Attach the engine lifting brackets and sling (Fig. 48).

3. Lower the engine carefully into the engine compartment. Make sure the exhaust manifolds are properly aligned with the muffler inlet pipes and the dowels in the block engage the holes in the flywheel housing.

4. On a vehicle with an automatic transmission, start the converter pilot into the crankshaft. It may be necessary to adjust the position of the transmission in relation to the engine if the input shaft will not enter the converter housing.

5. Install the converter housing upper bolts. Install the remaining converter housing to engine block retaining bolts.

6. Raise the front of the vehicle. Install the starter. Connect the starter cable.

7. Raise the engine approximately 1 or 2 inches and position the right exhaust manifold. Install and torque the retaining bolts to specifications.

8. Make sure the engine support insulator bolts are properly aligned with the support brackets on the frame. Completely lower the engine and install the engine support insulator lock washers and nuts. Torque the nuts to specifications.

9. Disconnect the engine lifting sling and remove the lifting brackets.

10. Place new gaskets on both sides of the exhaust control valve and position it over the inlet pipe studs on the right exhaust manifold. Connect the muffler inlet pipe to the exhaust manifold and torque the nuts to specifications.

11. Position a new gasket to the left exhaust manifold and connect the muffler inlet pipe to the manifold. Install and torque the nuts to specifications.

12. Remove the retainer securing the converter in the housing. Attach the converter to the flywheel. Install the transmission fluid filler tube bracket. Install the flywheel housing cover assembly. Install the oil cooler lines bracket. Connect the kickdown rod to the transmission.

13. Remove the support from the transmission and lower the vehicle.

14. Install the fan and spacer (or fan drive clutch). Torque the bolts to

specifications. Position the alternator drive belt and adjust the tension to specifications. Tighten the alternator mounting bolts to specifications. Connect the battery positive cable.

On a vehicle with air conditioning, adjust the compressor belt tension to specifications.

15. Connect the alternator wires, the water temperature sending unit wire, and connect the heater hose at the intake manifold. Connect the battery ground cable.

16. Connect the flexible fuel line and oil pressure sending unit wire.

17. Install the power steering pump bracket, coil bracket, and compressor and bracket assembly (if equipped with air conditioning).

Place the alternator drive belt on the crankshaft pulley. Install the power steering pump and adjust the belt tension to specifications. On a vehicle with air conditioning, install the compressor on the mounting bracket, and adjust the belt tension to specifications.

18. Connect the coil primary and high tension wires. Connect the wire loom at the distributor. Position the wire loom in the retaining clips on the left valve rocker arm cover.

19. On a vehicle with an automatic transmission, connect the kickdown rod to the carburetor. Install the kickdown rod retracting spring. Connect the transmission vacuum line. Install the oil level dipstick. Install the accelerator retracting spring. Connect the accelerator rod and adjust the accelerator linkage.

20. Install the radiator. Connect the radiator upper and lower hoses. Connect the transmission oil cooler lines. Install the hood.

21. Fill and bleed the cooling system. Connect the heater hose at the water pump. Fill the crankcase with the proper grade and quantity of oil.

22. Install the air cleaner, and operate the engine at fast idle and check all gaskets and hose connections for leaks.

23. Adjust the accelerator cable and the idle speed and fuel mixture as required, following the procedures in Part 23-01.

On a vehicle with an automatic transmission, check and adjust the transmission control linkage.

## 4 MAJOR REPAIR OPERATIONS

To perform the operations in this section, it will be necessary to remove the engine from the vehicle and install it on a work stand. For engine removal and installation procedures, refer to Section 3.

When installing nuts or bolts that must be torqued, oil the threads with light weight engine oil. **Do not oil threads that require oil resistant or water-resistant sealer.**

### CRANKSHAFT

The crankshaft and related parts are shown in Fig. 49.

#### REMOVAL

1. Disconnect the spark plug wires. Remove the spark plugs to allow easy rotation of the crankshaft.

2. Remove the fuel pump. Slide the water pump bypass hose clamp toward the intake manifold. Remove the water pump. On Thermactor engines, remove the air pump and brackets from the right cylinder head.

3. Remove the accessory drive pulley (if so equipped). Remove the

crankshaft damper cap screw and washer. Remove the power steering drive pulley. Install the puller on the damper (Fig. 22) and remove the damper.

4. Remove the crankshaft sleeve.

5. Remove the carburetor fuel inlet line. Remove the fuel pump. Remove the cylinder front cover and air conditioning idler pulley assembly (if so equipped). Remove the cover gasket.

6. Remove the crankshaft front oil slinger. Check the timing chain deflection, then remove the timing chain and sprockets by following the applicable steps under Cylinder Front Cover Removal.

7. Invert the engine on the work stand. Remove the flywheel, and engine rear cover plate. Remove the oil pan and gasket. Remove the oil pump and inlet tube and screen assembly.

8. Make sure all bearing caps (main and connecting rods) are marked so that they can be installed in their original locations. Remove the connecting rod bearing caps. Turn the crankshaft until the connecting rod from which the cap is being removed is down and remove the cap.

Push the connecting rod and piston assembly up into the cylinder.

9. Remove the main bearing caps.

10. Carefully lift the crankshaft out of the block so that the thrust bearing surfaces are not damaged. Handle the crankshaft with care to avoid possible fracture or damage to the finished surfaces. Be sure the oil seal surfaces on the crankshaft and crankshaft damper are properly cleaned.

### INSTALLATION

1. Remove the rear journal oil seal from the block and rear main bearing cap. Remove the rear main bearing cap to block side seals.

2. Remove the main bearing inserts from the block and bearing caps.

3. Remove the connecting rod bearing inserts from the connecting rod and caps.

4. If the crankshaft main bearing journals have been refinished as stated in Part 21-01, Section 2, to a definite undersize, install the correct undersize bearings. Be sure the bearing inserts and bearing bores are clean. Foreign material under the inserts will distort

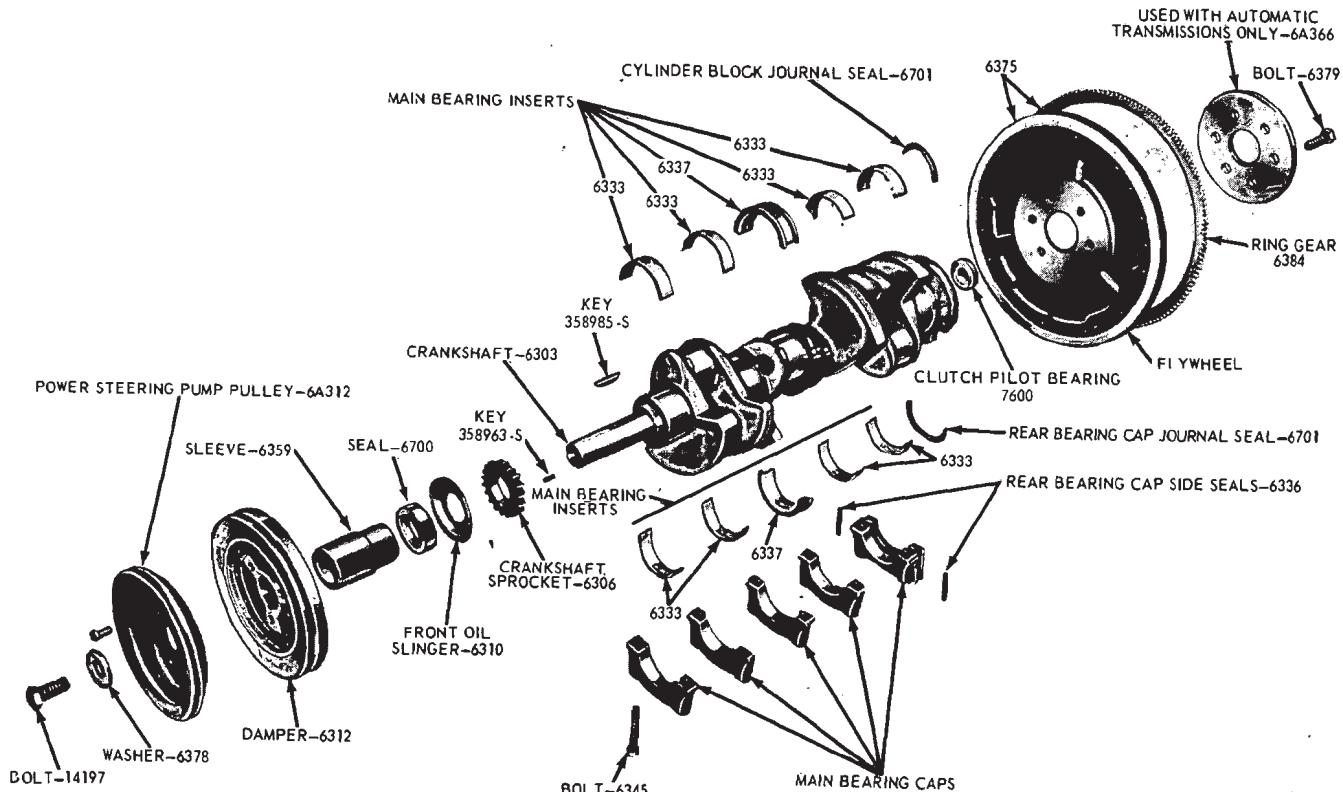


FIG. 49—Typical Crankshaft and Related Parts

the bearing and cause a failure.

5. Place the upper main bearing inserts in position in the bores with the tang fitting in the slot provided.

If the oil hole does not line up with the cylinder block oil passage, check the holes with a rod corresponding to the following diameters:

No. 1 Bearing—7/64 inch

No. 2 Bearing—9/64 inch

No. 3 Bearing—9/32 inch

No. 4 Bearing—5/32 inch

No. 5 Bearing—9/32 inch

If the rod passes through both the bearing and the block, sufficient lubrication is assured.

6. Install the lower main bearing inserts in the bearing caps.

7. Dip the seal halves in clean engine oil. Carefully install the upper seal (cylinder block) into its groove with undercut side of seal toward the FRONT of the engine (Fig. 34) and approximately 3/8 inch protruding above the partial surface.

8. Carefully lower the crankshaft into place. Be careful not to damage the bearing surfaces.

9. Check the clearance of each main bearing. Select-fit the bearing for proper clearance following procedures given under Fitting Main and Connecting Rod Bearings in Part 21-01.

10. After the bearings have been fitted, apply a light coat of engine oil to the journals and bearings.

11. Install the lower seal in the rear main bearing cap with undercut side of seal toward the FRONT of the engine (Fig. 34), allow the seal to protrude approximately 3/8 inch above the parting surface to mate with the upper seal when the cap is installed.

12. Dip the side seals in light en-

gine oil; then immediately install them in the grooves. Do not use sealer on the side seals. The seals are designed to expand when dipped in oil. Using sealer may retard this expansion. It may be necessary to tap the seals into place for the last 1/2 inch of travel. Do not cut the seal projecting ends.

13. Apply a thin coating of oil-resistant sealer to the rear main bearing cap at the rear of the top mating surface. Do not apply sealer to the area forward of the side seal groove. Install the rear main bearing cap. Torque the cap bolts to specifications.

14. Check the retainer side seals for leaks by squirting a few drops of oil into the parting lines between the rear main bearing cap and the cylinder block from the outside. Blow compressed air against the seals from the inside of the block. If air bubbles appear in the oil, it indicates possible oil leakage. This test should not be performed on newly installed seals until sufficient time has been allowed for the seals to expand into the seal grooves.

15. Install all the bearing caps, except the thrust bearing cap (No. 3 bearing). Be sure that the main bearing caps are installed in their original locations. Torque the bearing cap bolts to specifications.

16. Install the thrust bearing cap with the bolts finger-tight.

17. Pry the crankshaft forward against the thrust surface of the upper half of the bearing (Fig. 50).

18. Hold the crankshaft forward and pry the thrust bearing cap to the rear. This will align the thrust surfaces of both halves of the bearing.

19. Retain the forward pressure on the crankshaft. Torque the cap bolts

to specifications (Fig. 50).

20. Check the crankshaft end play by following the procedure in Part 8-1, Section 1.

21. Install new bearing inserts in the connecting rods and caps. Check the clearance of each bearing following the procedure under Main Bearing Replacement.

22. After the connecting rod bearings have been fitted, apply a light coat of engine oil to the journals and bearings.

23. Turn the crankshaft throw to the bottom of its stroke. Push the piston all the way down until the rod bearing seats on the crankshaft journal.

24. Install the connecting rod cap. Torque the nuts to specifications.

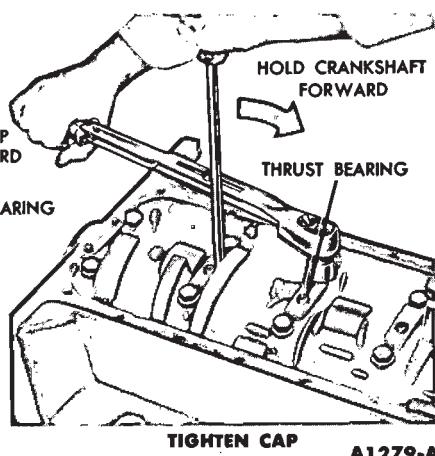
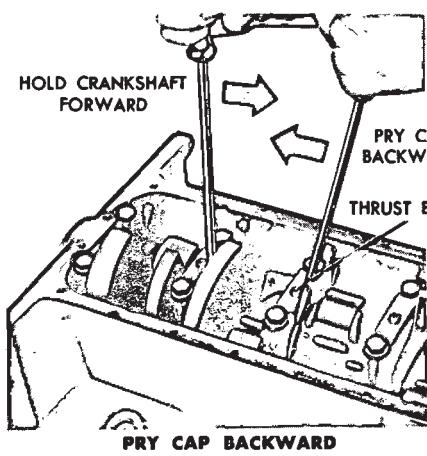
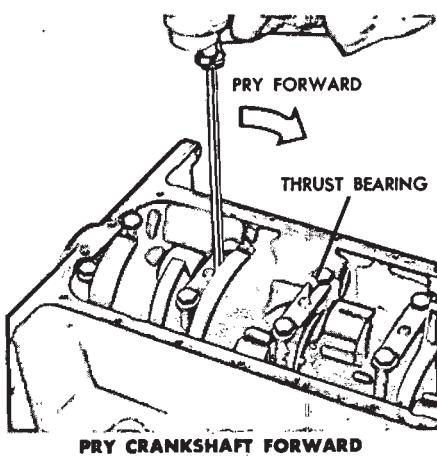
25. After the piston and connecting rod assemblies have been installed, check the side clearance between the connecting rods on each connecting rod crankshaft journal (Fig. 38).

26. Install the engine rear cover plate; then position the flywheel on the crankshaft. Install the attaching bolts. Torque the bolts to specifications.

On a flywheel for a manual-shift transmission, use tool 7563 to locate the clutch disc. Install the pressure plate. Tighten the attaching bolts.

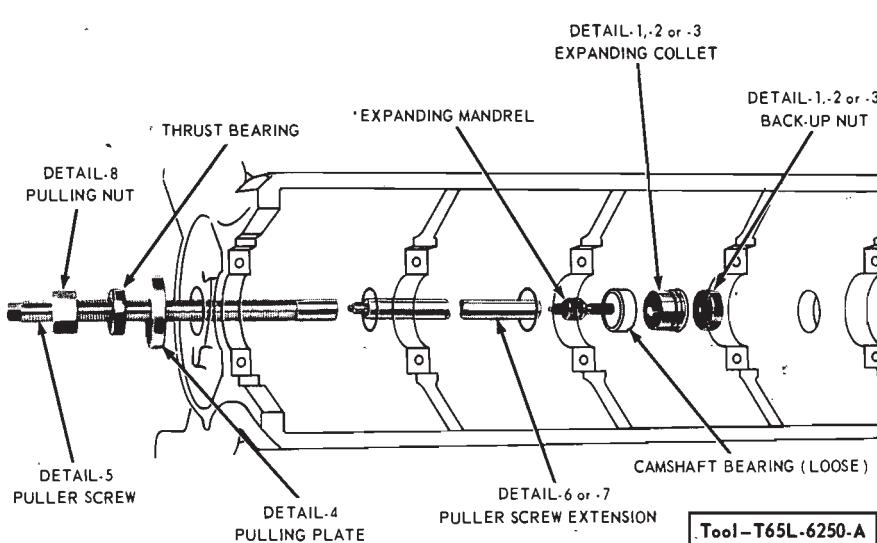
27. Install the timing chain and sprockets, cylinder front cover and crankshaft damper, following the procedures under Cylinder Front Cover Installation.

28. Clean the oil pan, oil pump and oil pump screen following the procedures in Part 21-01. Prime the oil pump by filling the inlet opening with oil and rotate the pump shaft until oil emerges from the outlet opening. Install the oil pump and oil



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FIG. 50—Thrust Bearing Alignment



**FIG. 51—Camshaft Bearing Replacement**

pan.

29. Install the oil filter, fuel pump and carburetor fuel inlet line. Install the spark plugs. On Thermactor engines, install the air pump and brackets on the right cylinder head.

30. Remove the engine from the work stand.

#### CAMSHAFT BEARING REPLACEMENT

Camshaft bearings are available pre-finished to size or standard and 0.015-inch undersize journal diameters. The bearings are not interchangeable from one bore to another.

1. Remove the camshaft, flywheel and the crankshaft following steps 3 through 8 under Camshaft Removal. Push the pistons to the top of the cylinders.

2. Remove the camshaft rear bearing bore plug. Remove the camshaft bearings (Fig. 51).

If the camshaft bearings are being removed with the tool shown in Fig. 51, the following procedure will apply. Select the proper size expanding collet and back-up nut and assemble on the expanding mandrel. With the expanding collet collapsed, install the collet assembly in the camshaft bearing, and tighten the back-up nut on the expanding mandrel until the collet fits the camshaft bearing. Assemble the puller screw and exten-

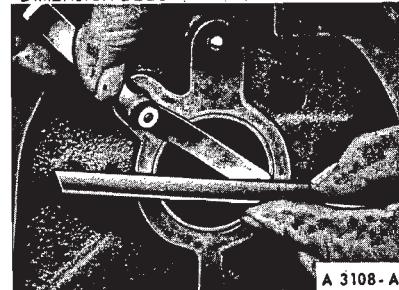
sion (if necessary) as shown and install on the expanding mandrel. Tighten the pulling nut against the thrust bearing and pulling plate to remove the camshaft bearing. Be sure to hold a wrench on the end of the puller screw to prevent it from turning. Repeat the procedure for each bearing. To remove the front bearing, install the puller screw from the rear of the cylinder block.

3. Position the new bearing at the bearing bores, and press them in place with the tool shown in Fig. 51. Be sure to center the pulling plate and the puller screw to avoid damage to the bearing. Wrap a cloth around the threads of the puller screw to protect the front bearing or journal. Failure to use the correct expanding collet can cause severe bearing damage. Align the oil holes in the bearings with the oil holes in the cylinder block when the bearings are installed. Be sure the front bearing is installed the specified dimension below the front face of the cylinder block (Fig. 52).

4. Install the core plug as detailed in Part 21-01, Section 2.

5. Install the camshaft, crankshaft, flywheel and related parts, following the appropriate procedures in Section 2 or Section 4, except do not check the connecting rod and main bearing clearances as a part of Camshaft Bearing Replacement. Remove the engine from the work stand.

INSTALL FRONT BEARING THE SPECIFIED DIMENSION BELOW FRONT FACE OF BLOCK



**FIG. 52—Camshaft Front Bearing Measurement**

#### CYLINDER ASSEMBLY REPLACEMENT

##### DISASSEMBLY

Follow steps 1 thru 11, 13 thru 20, and 24 thru 26 under Engine Disassembly. Remove the cylinder head dowels from the cylinder block. Remove the cylinder block drain plugs and remove the cylinder assembly from the work stand. Clean the gasket and seal surfaces of all parts and assemblies (refer to Part 21-01, Section 3).

##### ASSEMBLY

Install the replacement cylinder block assembly on a work stand. Install the cylinder block drain plugs and cylinder head dowels. Transfer all parts removed from the oil cylinder assembly to the new cylinder assembly, following the procedures in steps 22 thru 34 and 41 thru 62, under Engine Assembly. Check all assembly clearances.

#### CYLINDER BLOCK REPLACEMENT

Before replacing a cylinder block, determine if it is repairable, and make the necessary repairs following the procedures in Part 21-01, Section 2.

##### DISASSEMBLY

Follow steps 1 thru 34 under Engine Disassembly. Remove the cylinder head dowels and cylinder block drain plugs. Remove each intake and exhaust manifold and cylinder head as assemblies. Remove the cylinder block from the work stand. Clean the gasket and seal surfaces of all parts and assemblies (Part 8-1, Section 3).

## ASSEMBLY

Install the replacement cylinder block on a work stand. Install the cylinder block drain plugs and cylinder head dowels. Transfer all parts removed from the old cylinder block to the new cylinder block, following steps 7 thru 62. Check all assembly clearances. Install each manifold and cylinder head as an assembly.

## ENGINE DISASSEMBLY

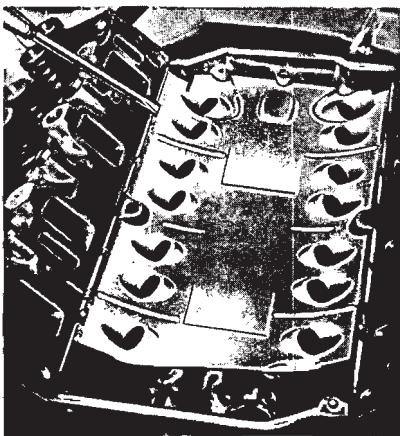
1. Install the engine on the work stand.

2. Remove the distributor cap and spark plug wires as an assembly.

3. Remove the vacuum hoses from the distributor and distributor vacuum control valve. Tag or identify each hose to facilitate installation and connection to the proper ports.

4. Remove the carburetor fuel inlet line. Remove the fuel pump and discard the gasket.

5. Slide the clamp on the water pump by-pass hose toward the water pump. Remove the automatic choke air heat tube and air inlet tube. On



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FIG. 53—Removing Baffle Plate

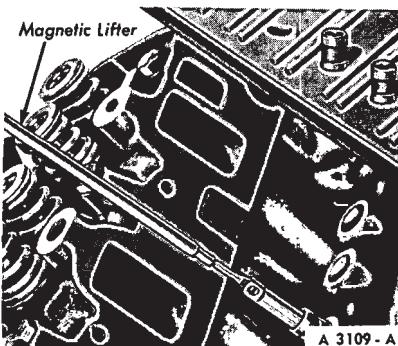


FIG. 54—Removing Valve Lifter

Thermactor engines, disconnect the air and vacuum hoses. Remove the air supply pump, air manifold assembly, air bypass valve, and air and vacuum hoses and brackets. Remove the valve rocker arm covers and positive crankcase ventilation system components.

Starting at the No. 4 cylinder, loosen the right rocker arm shaft support bolts in sequence, two turns at a time. After the bolts are all loosened, remove the valve rocker arm shaft assembly and the oil baffle plate. Starting at the No. 5 cylinder, follow the same procedure on the left valve rocker arm shaft support bolts.

6. Remove the valve push rods in sequence and put them in a rack so that they can be installed in their original bore.

7. Remove the distributor hold-down bolt and clamp and remove the distributor.

8. Install standard eye bolts with 5/16-18 threads in the left front and right rear rocker arm cover screw holes and attach the engine lifting sling (Fig. 9).

9. Raise the intake manifold and carefully remove it from the engine. Discard the intake manifold gaskets and seals.

10. Remove the baffle plate from the valve push rod chamber floor by prying up on the baffle with a screwdriver (Fig. 53).

11. Lift the valve lifters or tappets from the cylinder block and place them in a rack so that they can be installed in their original bore (Fig. 54).

The internal parts of each hydraulic valve lifter assembly are matched sets. Do not intermix the parts. Keep the assemblies intact until they are to be cleaned.

12. Remove the exhaust manifolds and the spark plugs. Remove the automatic choke air chamber cover from the right exhaust manifold.

13. Remove the cylinder head bolts.

14. Lift the cylinder heads off the block. Do not pry between the head and the block. Discard the cylinder head gaskets.

15. Remove the oil filter. Remove the oil filter adapter assembly and oil pressure sending unit as an assembly. Discard the gasket.

16. Remove the alternator, bracket and drive belt.

17. Remove the water pump, pulley and fan as an assembly. Remove the accessory drive pulley (if so

equipped).

18. On a vehicle with power steering remove the power steering pulley. Remove the damper (Fig. 22).

19. Remove the crankshaft sleeve.

20. Remove the cylinder front cover. Discard the gasket. Remove the crankshaft front oil slinger.

21. Check the timing chain deflection by following the procedure in Parts 8-1, Section 1.

22. Remove the camshaft sprocket cap screw and the fuel pump eccentric. Remove the sprockets and timing chain as an assembly (Fig. 24). Remove the crankshaft sprocket key.

23. Remove any ridge and/or carbon deposits from the upper end of the cylinder bores. Move the piston to the bottom of its travel and place a cloth on the top of the piston to collect the cuttings. Remove the cylinder ridge with a ridge cutter. Follow the instructions furnished by the tool manufacturer. Never cut into the ring travel area in excess of 1/32 inch when removing ridges. After the ridge has been removed, remove the cutter from the cylinder bore.

24. On a flywheel for a manual-shift transmission, mark the pressure plate cover so that it can be installed in its original position. Remove the clutch pressure plate and cover assembly. Remove the flywheel. Remove the rear cover plate.

25. Remove the oil pump and inlet tube as an assembly. Remove the oil pump intermediate shaft. Discard the oil pump gasket.

26. Make sure all connecting rods and caps are marked so that they can be installed in their original locations. Turn the crankshaft until the connecting rod being removed is down. Remove the rod cap.

27. Push the connecting rod and piston assembly out the top of the cylinder with the handle end of a hammer. Avoid damage to the connecting rod journal or the cylinder wall when removing the piston and rod.

28. Remove the bearing inserts from the connecting rods and caps. Install the rod caps on the connecting rods from which they were removed.

29. Remove the main bearing caps.

30. Carefully lift the crankshaft out of the cylinder block so that the thrust bearing surfaces are not damaged. Handle the crankshaft with care to avoid possible fracture or damage to the finished surfaces.

31. Remove the rear journal oil seal from the block and rear bearing cap, and remove the cap to block side

seals.

32. Remove the main bearing inserts from the block and bearing caps. Install the main bearing caps in their original positions.

33. Carefully remove the camshaft. Avoid damaging the journals and lobes.

34. Remove the camshaft rear bearing bore plug. Remove the camshaft bearings (Fig. 51).

## ENGINE ASSEMBLY

If the cylinder block is to be replaced, transfer the cylinder head dowels and cylinder block drain plugs to the new cylinder block. Also, omit steps 1 thru 6 below, if a new cylinder block is used.

1. If the original cylinder block is used, remove the glaze from the cylinder bores by following the procedures in Part 21-01, Section 2.

2. Invert the engine on the work stand.

3. Position the new camshaft bearings at the bearing bores and press them in place with the tool shown in Fig. 51. Align the oil holes in the cylinder block when the bearings are installed. Be sure the camshaft front bearing is installed to the specified dimension below the front face of the cylinder block (Fig. 52).

4. Check the oil passage that feeds the rocker arm shafts for obstructions by squirting oil into the opening on each cylinder bank and observing the flow through the oil holes at Nos. 2 and 4 bearings.

5. Install the core plug as detailed in Part 21-01, Section 2.

6. Oil the camshaft journals and apply Lubriplate to all lobes; then carefully slide it through the bearings. Check the camshaft end play and correct as required.

7. Be sure that the rear oil seal grooves are clean. Dip the seal halves in clean engine oil. Carefully install the upper seal (cylinder block) into its groove with undercut side of seal toward the FRONT of the engine (Fig. 34) and approximately 3/8 inch protruding above the parting surface.

8. If the crankshaft main bearing journals have been refined to a definite undersize, install the correct undersize bearings. Be sure the bearing inserts and bearing bores are clean. Foreign material under the inserts will distort the bearing and cause a failure.

Place the upper main bearing inserts in position in the bore with the tang fitting in the slot provided.

9. Install the lower main bearing inserts in the bearing caps.

10. Carefully lower the crankshaft into place. Be careful not to damage the bearing surfaces.

11. Check the clearance of each main bearing following the procedure under Main Bearing Replacement.

12. After the bearings have been fitted, apply a light coat of engine oil to the journals and bearings.

13. Be sure that the oil seal grooves in the rear main bearing cap are clean. Install the lower seal in the rear main bearing cap are clean. Install the lower seal in the rear main bearing cap with the seal lip toward the FRONT of the engine (Fig. 34). Allow the seal to protrude approximately 3/8 inch above the parting surface to mate with the upper seal when the cap is installed. Apply a thin coating of oil-resistant sealer to the rear main bearing cap at the rear of the top mating surface. Do not apply sealer to the area forward of the side seal groove.

14. Install the rear main bearing cap and the remainder of the caps, except the thrust bearing cap (No. 3 bearing). Be sure that the main bearing caps are installed in their original locations. Torque the bearing cap bolts to specifications.

15. Dip the side seals in light engine oil; then immediately install them in the grooves. Do not use sealer on the side seals. The seals are designed to expand when dipped in oil. Using sealer may retard this expansion. It may be necessary to tap the seals into place for the last 1/2 inch of travel. Do not cut the seal projecting ends.

16. Check the retainer side seals for leaks by squirting a few drops of oil into the parting lines between the rear main bearing cap and the cylinder block from the outside. Blow compressed air against the seals from the inside of the block. If air bubbles appear in the oil, it indicates possible oil leakage. This test should not be performed on newly installed seals until sufficient time has been allowed for the seals to expand into the seal grooves.

17. Install the thrust bearing cap following steps 11 thru 14 under Crankshaft Installation. Check the crankshaft end play by following the procedure in Part 21-01, Section 1.

18. Turn the engine on the work stand so that the front end is up.

19. Install the pistons and connecting rods by following steps 1 thru 9 under Piston and Connecting Rod

## Assembly Installation.

20. Position the sprockets and timing chain on the camshaft and crankshaft (Fig. 24). Be sure the timing marks on the sprockets are positioned as shown in Fig. 23.

21. Lubricate the timing chain and sprockets with engine oil.

22. Install the fuel pump eccentric and the camshaft sprocket cap screw. Torque the sprocket cap screw to specifications. Install the crankshaft front oil slinger.

23. Clean the cylinder front cover and the cylinder block gasket surfaces. Grease and install a new crankshaft front oil seal (Fig. 25).

24. Coat the gasket surface of the block and cover and the cover bolt threads with sealer. Position a new gasket on the block.

25. Install the alignment pilot tool on the cylinder front cover so that the keyway in the pilot aligns with the key in the crankshaft. Position the cover and pilot over the end of the crankshaft and against the block (Fig. 27).

26. Install the cylinder front cover bolts finger-tight. While pushing in on the pilot, torque the cover bolts to specifications. Remove the pilot.

27. Apply Lubriplate to the outer surface (front oil seal contact surface) of the crankshaft sleeve, and install the sleeve.

28. Apply a white lead and oil mixture to the inside diameter of the crankshaft damper.

29. Line up the damper keyway with the key on the crankshaft, and install the damper on the crankshaft (Fig. 38). Install the power steering pulley on the crankshaft damper. Install the damper cap screw and washer, and torque the screw to specifications.

30. Clean the water pump gasket surfaces and apply sealer. Position new gaskets on the pump and install the water pump, pulley, and fan as an assembly.

31. Using a new gasket, install the fuel pump.

32. Turn the engine on the work stand so that the top of the engine is up.

33. Clean the cylinder head and block gasket surfaces. All engines use a specially treated composition gasket. Do not apply sealer to the composition cylinder head gasket. Guided by the word FRONT on the gasket, install the head gasket over the cylinder head dowels.

34. Place the cylinder head on the engine.

**35.** The cylinder head bolt tightening procedure is performed in three progressive steps. Torque the bolts in sequence (Fig. 20) to 70 ft-lbs, then to 80 ft-lbs, and finally to specifications. When cylinder head bolts have been tightened following this procedure, it is not necessary to retorque the bolts after extended operation. However, on cylinder heads with composition gaskets, the bolts may be checked and retorqued, if required.

**36.** Coat the mating surfaces of the exhaust manifold with a light film of graphite grease.

**37.** Using a new gasket, install the automatic choke air chamber cover on the right exhaust manifold. Be sure the cover is securely fastened.

**38.** Position a new gasket over the muffler inlet pipe studs of the exhaust manifolds.

**39.** Position the exhaust manifolds on the cylinder heads and install the attaching bolts and flat washers.

Torque the attaching bolts to specifications, working from the center to the ends.

**40.** Install the spark plugs.

**41.** Invert the engine on the work stand. Position the oil pump drive shaft into the distributor socket. With the shaft firmly seated in the distributor socket, the stop on the shaft should touch the roof of the crankcase. Remove the shaft and position the stop as necessary.

**42.** With the stop properly positioned, insert the oil pump drive shaft into the oil pump.

**43.** Prime the oil pump by filling either the inlet or outlet port with engine oil. Rotate the pump shaft to distribute the oil within the pump body.

**44.** Position a new gasket on the pump housing and install the pump and shaft as an assembly. Do not attempt to force the pump into position if it will not seat readily. The drive shaft hex may be misaligned with the distributor shaft. To align, rotate the intermediate shaft into a new position.

**45.** Position a new gasket on the oil pan and place the pan on the block. Install the attaching screws and torque them from the center outward to specifications.

**46.** Invert the engine on the work stand. Install the baffle plate in the valve push rod chamber. Position one

side of the baffle plate and press the other side into place.

Use the hydraulic valve lifter leak-down tester (Part 21-01) to fill the lifters with test fluid. Coat the outside of each valve lifter with engine oil to provide initial lubrication. Place each lifter in the bore from which it was removed.

**47.** Clean the mating surfaces of the intake manifold, cylinder heads and cylinder block. Use a suitable solvent to remove all traces of oil.

**48.** Coat the intake manifold and cylinder block seal surfaces with a quick-setting seal adhesive. Apply a non-hardening sealer to the mating lines of the cylinder heads and cylinder block.

**49.** Position new seals on the cylinder block and new gaskets on the cylinder heads. Be sure the seals are properly positioned during installation as the adhesive sticks to the seals immediately on contact. Position the manifold gasket slots over the end tabs on the seals. Coat these four connections with a non-hardening sealer. Be sure the holes in the gaskets are aligned with the holes in the cylinder heads.

**50.** Install the eye bolts in the intake manifold and attach the engine lifting sling and carefully lower the intake manifold on the engine (Fig. 9).

**51.** Position the intake manifold. After the intake manifold is in place, run a finger around the seal area to make sure the seals are in place. If seals are not in place, remove the intake manifold and position the seals.

**52.** Start the water pump bypass hose on the intake manifold.

**53.** Be sure the holes in the manifold gaskets and manifold are in alignment. Apply a non-hardening, oil-resistant sealer to the under side of each manifold attaching bolt head. Install the manifold attaching bolts. Torque the intake manifold bolts in two steps (Fig. 11).

Torque all bolts in sequence to specifications.

After completing the remaining assembly steps; operate the engine until it reaches normal operating temperature; then retorque the manifold bolts in sequence to specifications.

**54.** Remove the engine lifting sling and eye bolts.

**55.** Refer to Valve Rocker Arm Shaft Assembly Installation and install the valve rocker arm shaft assemblies by following steps 1 thru 8.

**56.** Install the automatic choke air heat tube and air inlet tube.

**57.** Rotate the crankshaft damper until the No. 1 piston is on TDC of the compression stroke; then position the distributor in the block with the rotor at the No. 1 firing position and the points open. Install the hold down clamp.

**58.** Install the distributor cap and spark plug wire. Connect the spark plug wires.

**59.** Connect the carburetor fuel inlet line to the fuel pump. Using a new clamp, connect the line to the fuel filter. Install the distributor vacuum hoses. Be sure they are connected to the proper ports.

**60.** Install the engine rear cover plate. Position the flywheel on the crankshaft and install the attaching bolts. Torque the bolts alternately to specifications.

On a flywheel for a manual-shift transmission, use tool 7563-E to locate the clutch disc. Install the pressure plate.

**61.** Clean the oil filter adapter gasket surfaces. Apply oil-resistant sealer to a new adapter gasket, and install the adapter assembly and gasket.

**62.** Clean the adapter filter recess. Coat the gasket on a new filter with oil. Place the filter in position on the adapter. Hand tighten the filter until the gasket contacts the adapter face, and advance it 1/2-turn.

On Thermactor engines install the air bypass valve, air manifold assembly and air supply pump. Install the air and vacuum hoses and brackets.

**63.** Remove the engine from the work stand, and install it in the vehicle. Install the air cleaner; fill and bleed the cooling system; fill the crankcase with the proper grade and quantity of engine oil; then operate the engine and check for oil and coolant leaks. Check the ignition timing; adjust the engine idle speed, idle fuel mixture, accelerator cable, and anti-stall dashpot (if applicable). Connect the distributor vacuum hose.

On a vehicle with an automatic transmission, adjust the transmission control linkage.

## 5 SPECIFICATIONS

NOTE: All specifications are given in inches unless otherwise noted											
ENGINE IDENTIFICATION											
WARRANTY PLATE CODE AND APPLICATION											
Engine	Ford	Mercury	Cougar	Fairlane	Falcon	Montego	Mustang	Fairlane Ranchero	Lincoln Continental Mark III	Thunderbird	Meteor
390-2V	Y	Y									Y
①428-4V CJ			Q				Q				
①428-4V CJ Ram Air			R				R				
①428-4V P	P	P									
① Thermactor equipped											

CA1057-A1

### GENERAL SPECIFICATIONS

Engine	Compression Ratio	Bore and Stroke	Taxable Horsepower	Brake Horsepower	Gross Torque Ft-Lbs.
390-2V	9.5:1	4.05 x 3.784	52.48	270 @ 4400	390 @ 2600
428-P	10.5:1	4.13 x 3.984	54.58	360 @ 5400	459 @ 3200
428-CJ	10.6:1			335 @ 5200	440 @ 3400

CA1057-A2

Engine	Compression Pressure PSI (Sea Level @ Cranking Speed)	Engine Idle Manifold Vacuum	Oil Pressure-Hot @ 2000 RPM	Firing Order	Belt Tension (Ft. Lbs.)
390	When checking compression, take the highest compres- sion reading and compare it to the lowest reading. The lowest reading must be within 75% of the highest.	17	35-60		New 140 Used 110
428		17		1-5-4-2- 6-3-7-8	

CA1057-A3

### CYLINDER HEAD

Engine	Combustion Chamber Volume	Valve Guide Bore Diameter (Standard Intake and Exhaust)	Valve Seat Width	Valve Seat Angle	Valve Seat Runout (Maximum)	Arrangement (Front to Rear)	Surface Flatness ①
390- 428 P	68.1-71.1	0.060- 0.080	0.070- 0.090	Intake 30° Exhaust 45°	0.0015	Right and Left E-I-E-I-I-E-I-E	0.003 in any 6 in. 0.007 Overall
428 CJ	72.7-75.7	0.3728-0.3738					
① Head Gasket Surface Finish R.M.S. ..... 90-150.							

CA1057-A4

## VALVE ROCKER ARMS, ROCKER ARM SHAFT, PUSH RODS AND TAPPETS

Engine	Rocker Arm Shaft O.D.	Rocker Arm To Rocker Shaft Clearance ①	Rocker Arm Bore Diameter	Rocker Arm Lift Ratio	Valve Push Rod (Maximum Runout)	VALVE TAPPET OR LIFTER		
						Standard Diameter	Clearance To Bore ②	Hydraulic Lifter Leakdown Rate
390- 428	0.839-0.840	0.002-0.005	0.842- 0.844	1.73:1	0.025	0.8740 0.8745	0.0007- 0.0027	5-50 Seconds Maximum— Measured at 1/16 inch plunger travel
①Wear Limit -0.0060		②Wear Limit -0.005						

CA1057-A5

## VALVE SPRINGS

Engine	Valve Spring Pressure Lbs. @ Specified Length		Valve Spring Free Length Approximate	Valve Spring Assembled Height Pad to Retainer	Valve Spring Out-of-Square (Maximum)
	Pressure	Wear Limit			
390	85-95 @ 1.820 209-231 @ 1.380	77 @ 1.820 188 @ 1.380	2.12	1 13/16-1 27/32	5/64 (.078)
428 Police, 428 CJ	80-90 @ 1.820 255-280 @ 1.320	72 @ 1.820 230 @ 1.320	2.06		

CA1057-AA5

## VALVES

Engine	Valve Stem To Valve Guide Clearance		Hydraulic Lifters		Valve Head Diameter		Valve Face Angle ③	Allowable Valve Stem Tip Length
	Intake	Exhaust	Allowable	Desired	Intake	Exhaust		
390					2.022-2.037	1.551-1.566		
428 P	0.0010- 0.0027 ①	0.0015- 0.0032 ①	0.100-0.200	0.100- 0.150			Intake and Exhaust 44°	N.A.
428 CJ	0.0015- 0.0032				2.022-2.037	1.551-1.566	Intake 29° Exhaust 44°	
①Wear Limit 0.0055 All engines								
②Valve face runout All Engine ..... Maximum 0.0020								

CA1057-A6

## VALVES (Continued)

Engine	Valve Stem Diameter							
	Standard		0.003 Oversize		0.015 Oversize		0.030 Oversize	
	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust
390								
428 P	0.3711- 0.3718	0.3706- 0.3713	0.3741- 0.3748	0.3736- 0.3743	0.3861- 0.3868	0.3856- 0.3863	0.4011- 0.4018	0.4006- 0.4013
428 CJ								

CA1057-A7

**CAMSHAFT**

Engine	Lobe Lift①		Theoretical Valve Lift		Camshaft		Camshaft Journal to Bearing Clearance					
	Intake	Exhaust	Intake	Exhaust	End Play	Wear Limit	Clearance	Wear Limit				
390-2V	0.2470	0.2490	0.4270	0.4300	0.001-0.007	0.009	0.001-0.003	0.006				
428 P	0.2780	0.2830	0.4810	0.4900								
428 CJ												

①Maximum allowable lobe lift loss (All engines) ..... 0.005

CA1057-A8

Item	Bearing	390, 428
Camshaft Journal Diameter— Standard①	(No. 1)	2.1238-2.1248
	(No. 2)	
	(No. 3)	
	(No. 4)	
	(No. 5)	
Camshaft Bearings Inside Diameter	(No. 1)	2.1258-2.1268
	(No. 2)	
	(No. 3)	
	(No. 4)	
	(No. 5)	
Camshaft Bearing Location②	(No. 1)	0.0050-0.0200
①Camshaft journal maximum runout		
All engines ..... 0.0005		
Camshaft journal maximum out-of-round		
390 ..... 0.0005		
All Others ..... 0.0010		
②Distance in inches that the front edge of the bearing is installed towards the rear from the front face of the cylinder block.		

CA1057-A9

**CAMSHAFT VALVE TIMING EVENTS**

Engine	Intake Valve		Exhaust Valve	
	Model	Opens BTC	Closes ABDC	Opens BBDC
390-2V	0.004 @ 13°	0.006 @ 63°	0.004 @ 63°	0.005 @ 23°
428 Police & CJ	0.004 @ 18°	0.006 @ 72°	0.004 @ 82°	0.006 @ 28°

CA1057-A10

**CAMSHAFT DRIVE MECHANISM**

Engine	Camshaft Sprocket Face Runout T.I.R. Max.	Timing Chain Deflec. tion (Maximum)
390	0.006	0.500
428		

CA1057-A12

**CYLINDER BLOCK**

Engine	Cylinder Bore Diameter <sup>①</sup>	Cylinder Bore Diameter 0.003 O.S.	Tappet Bore Diameter	Main Bearing Bore Diameter	Cylinder Block Distributor Shaft Bearing Bore Diameter	Head Gasket Surface Flatness <sup>②</sup>
390	4.0500-4.0524	4.0524-4.0536	0.8752-0.8767	2.9417-2.9425	0.4525-0.4535	0.003 inch in any 6 inches or 0.007 inch Overall
428	4.1300-4.1324	4.1324-4.1336				
All						③Head gasket surface finish RMS ..... 60-150

①Maximum out-of-round ..... 0.001  
Wear Limit ..... 0.005  
Cylinder bore surface finish RMS  
All ..... 15-35

CA1057-A13

**CRANKSHAFT AND FLYWHEEL**

Engine	Main Bearing Journal Diameter <sup>③</sup>	Main Bearing Journal Runout-Maximum	Main Bearing Journal Thrust Face Runout	Main Bearing Journal Taper Max.	Thrust Bearing Journal Length	Main Bearing Surface Finish R.M.S. Maximum	
						Journal	Thrust Face
390	2.7484-2.7492	0.004	0.001	0.0003 Per Inch	1.124-1.126	12	20 Front 20 Rear
428							

③Wear Limit 0.0035  
④Connecting rod and main bearing journal out-of-round maximum 0.0004 (all engines)

CA1057-A14

**CRANKSHAFT AND FLYWHEEL (Continued)**

Engine	Connecting Rod Journal Diameter <sup>⑤</sup>	Connecting Rod Bearing Journal Maximum Taper	Crankshaft Free End Play	Crankshaft To Rear Face Of Block Runout T.I.R. Max.	Flywheel Clutch Face Runout	Flywheel O.D. Runout Transmission	
390	2.4380-2.4388	0.0003 Per Inch	0.004-0.010 <sup>⑥</sup>	0.010	0.010	Standard	Automatic
428						0.018	0.017

⑤Wear Limit 0.012 ⑥Wear Limit 0.014  
⑦Connecting rod and main bearing journal out-of-round maximum 0.0004 (all engines)

CA1057-A15

**CRANKSHAFT BEARINGS**

Engine	Connecting Rod Bearings			Main Bearings		
	To Crankshaft Clearance		Wall Thickness-Standard <sup>⑧</sup>	To Crankshaft Clearance		Wall Thickness-Standard <sup>⑨</sup>
	Desired	Allowable		Desired	Allowable	
390	0.001-0.0015	0.001-0.003	0.0755-0.0760			
428 CJ	0.0015-0.0025	0.001-0.003	0.0752-	0.0010-0.0015	0.008-0.020	
428 Police	0.001-0.002	0.001-0.003	0.0756		0.0005-0.0025	0.0955-0.0960

⑧0.002 U.S. Thickness  
390 & 428 ..... Add 0.0010 to Standard Thickness

⑨0.002 U.S. Thickness ..... Add 0.0010  
Standard Thickness

CA1057-A16

## CONNECTING ROD

Engine	Piston Pin Bore Or Bushing I.D. <sup>①</sup>	Connecting Rod Bearing Bore Diameter <sup>②</sup>	Connecting Rod Length Center To Center	Connecting Rod Alignment Maximum Total <sup>③</sup>		Connecting Rod Assembly (Assembled To Crankshaft)	
				Twist	Bend	Side Clearance	Wear Limit
390	0.9752-0.9755	2.5907-2.5915	6.486-6.490	0.012	0.004	0.010-0.020	0.023
428							
① Piston pin bushing or bore Maximum out-of-round 390, and 428 ..... 0.0004 Maximum taper 390, and 428 ..... 0.0003				② Connecting rod bearing bore maximum out-of-round and taper (All Engines)...0.0004 ③ Pin bushing and crankshaft bearing bore must be parallel and in the same vertical plane within the specified total difference at ends of 8-inch long bar measured 4 inches on each side of rod.			

CA1057-A17

## PISTON

Engine	Diameter <sup>①</sup>			Piston To Cylinder Bore Clearance	Piston Pin Bore Diameter	Ring Groove Width	
	Coded Red	Coded Blue	0.003 Oversize			Upper Compression Ring All Engines .....	0.080-0.081
390	4.0481- 4.0493	4.0493- 4.0505	4.0505- 4.0517	0.0015-0.0023	0.9752- 0.9755	Lower Compression Ring 390, 428 .....	0.096-0.097
428	4.1284- 4.1290	4.1296- 4.1302	4.1308- 4.1314	0.0015-0.0023		Oil Ring All engines .....	0.1880-0.1890
① Measured at the piston pin bore centerline at 90° to the pin bore.							

CA1057-A18

## PISTON PIN

Engine	Diameter				To Piston Clearance	To Connecting Rod Bushing Clearance
	Length	Standard	0.001 Oversize	0.002 Oversize		
390	3.150-3.170	0.9750-0.9753	0.9760-0.9763	0.9770-0.9773	① 0.0001-0.0003	① 0.0001-0.0003
428	3.165-3.175					
① Wear Limit 0.0008    ② Interference Fit						

CA1057-A19

## PISTON RINGS

	Ring Width		Side Clearance		Ring Gap Width		
	Compression Ring		③ Compression Ring	Oil Ring	Compression Ring		Oil Ring ④
	Top	Bottom	Top		Top	Bottom	
390	0.077-0.078	0.093-0.094	0.002-	0.002-			0.015-0.055
428	0.077-0.078	0.077-0.078	0.004	0.004	0.010-0.020	0.010-0.020	0.010-0.035
⑤ Wear Limit (All Engines) ..... 0.006    ⑥ Steel Rail							

CA1057-A20

**OIL PUMP**

Engine	Rotor-Type Oil Pump Relief Valve Spring Tension Lbs @ Specified Length	Drive Shaft To Housing Bearing Clearance	Relief Valve Clearance	Rotor Assembly End Clearance	Outer Race To Housing (Radial Clearance)
390	8.7 - 9.5 @ 1.56	0.0015-	0.0015-	0.0011-	0.006-
428	11.1 - 11.8 @ 1.56	0.0029	0.0029	0.0041	0.013

CA1057-A21

**APPROXIMATE OIL PAN CAPACITIES<sup>①</sup>**

Engine	U.S. Measure	Imperial Measure
390	5 Quarts	4 Quarts
428	5 Quarts	4 Quarts

<sup>①</sup>Includes one quart with filter replacement

CA1057-A22

**TORQUE LIMITS**

Engine	Cylinder Head Bolts			Oil Pan To Cylinder Block	Manifolds To Cylinder Head		Water Outlet Housing	Distributor Vacuum Control Valve	Flywheel To Crankshaft
	Step 1	Step 2	Step 3		Intake	Exhaust			
390, 428	70	80	80-90	10-12	32-35	18-24	12-15	15-18	75-85

CA1057-A23

**TORQUE LIMITS**

Engine	Oil Inlet Tube To Oil Pump	Main Bearing Cap Bolts	Oil Pan Drain Plug	Oil Pump To Cylinder Block	Oil Pump Cover Plate	Oil Filter Adapter To Cylinder Block	Oil Filter To Adapter Or Cylinder Block	Cylinder Front Cover
390-428	12-15	95-105	15-20	20-25	9-12	14-19	With grease on the gasket surface, hand-tighten until gasket contacts adapter face, then tighten 1/2 turn more.	12-15

CA1057-A24

**TORQUE LIMITS (Continued)**

Engine	Water Pump To Cylinder Block Or Front Cover	Camshaft Sprocket To Camshaft	Camshaft Thrust Plate In Block	Damper Or Pulley To Crankshaft	Connecting Rod Nuts	Valve Rocker Arm Cover
390	20-25	35-45	12-15	70-90	40-45	
428					53-58	4-7

CA1057-A25

**TORQUE LIMITS (Continued)**

Engine	Fuel Pump To Cylinder Block Or Cylinder Front Cover	Pulley To Damper Bolts	Air Manifold To Cylinder Head-Thermactor	Check Valve To Air Manifold Or Supply Tube-Thermactor	Adjusting Arm To Air Pump-Thermactor	Air Pump Mounting Bolts-Thermactor	Air Pump Drive Pulley To Pump Hub Thermactor
390	20-24	UBS Bolts 25-35 Place Bolts 35-45	16-19	16-19	16-20	16-26	7-9
428							

CA1057-A26

**TORQUE LIMITS (Continued)**

Engine	Valve Rocker Shaft Support To Cylinder Head	Valve Rocker Arm Stud To Cylinder Head	Valve Push Rod Chamber Cover	Valve Rocker Arm Adjusting Nut
390	40-45			
428		NA	NA	NA

CA1057-A27

**ENGINE SUPPORT TORQUE LIMITS-FT. LBS.**

Supports	Ford-Mercury- Meteor	Cougar- Mustang	Supports	Ford-Mercury- Meteor	Cougar- Mustang
	390-428	428		390-428	428
ENGINE FRONT SUPPORTS			ENGINE REAR SUPPORTS		
Front Insulator to Engine	35-50		Rear Support Assembly to Transmission	40-50	30-45
Front Support Insulator Bracket to Engine		35-60	Insulator Assembly to Transmission: Standard Automatic		
Front Support Insulator Bracket to Insulator		30-50	Insulator to Crossmember		
Front Insulator to Support Bracket	45-60	20-30	Rear Support Assembly to Crossmember	20-30	25-35
Front Insulator to Mounting Bracket			Crossmember to Frame	70-100	10-20
Support Bracket to Mounting Bracket		20-30	Frame Bracket to Frame Rail Nuts		
Support Bracket to Frame	20-30		Block Bracket to Block Bolts		
Support Bracket to Crossmember			Insulator to Extension Housing Bolts		
Mounting Bracket to Frame		20-30	Crossmember to Frame Side Rail Nut		
Crossmember Assembly to Frame		45-60	Front Insulator Assembly to Block Attaching Bolts		
Insulator to Frame Bracket Through Bolt (Nut)					

CA1057-A28

**THERMATOR DRIVE BELT TENSION**

New	140 Lbs.	Used (any belt operated over 10 minutes)	110 Lbs.
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**LUBRICANTS**

	Ford Part No.
Exhaust Control Valve Lubricant	COAZ-19A501-A, R-149-A

**SEALERS**

	Ford Part No.
Loctite (thread locking compound)	C3AZ-19554-A

CA1057-A30

**TORQUE LIMITS FOR VARIOUS SIZE BOLTS**

CAUTION: If any of the torque limits listed in this table disagree with any of those listed in the preceding tables, the limits listed in the preceding tables prevail.

Size (Inches)	1/4-20	1/4-28	5/16-18	5/16-24	3/8-16	3/8-24
Torque (Ft-lbs)	6-7	6-9	12-15	15-18	23-28	30-35
Size (Inches)	7/16-14	7/16-20	1/2-13	1/2-20	9/16-18	5/8-18
Torque (Ft-lbs)	45-50	50-60	60-70	70-80	85-95	130-145

CA1057-A31

# **PART 21-07 429 and 460 V8 Engines**

MODEL APPLICATION		Ford, Mercury, Meteor, Fairlane, Montego and Thunderbird Continental Mark III and Lincoln Continental	
429			
460			
COMPONENT INDEX	Page	COMPONENT INDEX	Page
<b>CAMSHAFT</b>		<b>MANIFOLD - INTAKE</b>	
Camshaft Bearing Installation .....	07-22	Cleaning .....	07-04
Camshaft Bearing Removal .....	07-22	Inspection .....	07-04
Cleaning and Inspection .....	07-12	Installation .....	07-04
Installation .....	07-12	Removal .....	07-04
Rear Bearing Bore Plug .....	07-13		
Removal .....	07-12	<b>MAIN AND CONNECTING ROD BEARINGS</b>	
Repairs .....		Connecting Rod Bearing	
		Installation .....	07-15
<b>CRANKSHAFT</b>		Connecting Rod Bearing	
Cleaning and Inspection .....	07-21	Removal .....	07-15
Rear Oil Seal .....	07-14	Main Bearing Installation .....	07-14
Installation .....	07-21	Main Bearing Removal .....	07-14
Removal .....	07-21		
Repairs .....	07-21	<b>OIL FILTER</b>	
		Installation .....	07-17
<b>CYLINDER HEADS</b>		Removal .....	07-17
Assembly .....	07-08		
Cleaning and Inspection .....	07-07	<b>OIL PAN</b>	
Disassembly .....	07-07	Continental Mark III .....	07-17
Installation .....	07-06	Ford, Mercury and Thunderbird .....	07-18
Removal .....	07-06	Lincoln Continental .....	07-18
Repairs .....	07-08		
<b>CYLINDER FRONT COVER AND TIMING CHAIN</b>		<b>OIL PUMP</b>	
Cleaning and Inspection .....	07-11	Assembly .....	07-19
Installation .....	07-11	Cleaning and Inspection .....	07-19
Removal .....	07-10	Disassembly .....	07-19
		Installation .....	07-19
<b>ENGINE</b>		Removal .....	07-19
Assembly .....	07-24		
Cylinder Assembly .....	07-23	<b>PISTONS AND CONNECTING RODS</b>	
Cylinder Block .....	07-23	Assembly .....	07-16
Disassembly .....	07-23	Cleaning and Inspection .....	07-16
Installation .....	07-20	Disassembly .....	07-16
Removal .....	07-19	Installation .....	07-16
		Removal .....	07-16
<b>ENGINE SUPPORTS</b>		Repairs .....	07-16
Front Support Insulator .....	07-03		
Rear Support Insulator .....	07-04	<b>SPECIFICATIONS</b> .....	07-26
<b>EXHAUST EMISSION CONTROL SYSTEM</b>			
Description .....	07-02	<b>VALVES</b>	
		Installation .....	07-08
<b>FLYWHEEL</b>		Removal .....	07-07
Inspection .....	07-17	Valve Clearance - Checking and Adjustment	
Installation .....	07-17	Procedure .....	07-09
Removal .....	07-17	Valve Spring, Retainer and Stem Seal .....	07-08
<b>MANIFOLDS - EXHAUST</b>			
Cleaning .....	07-06	<b>VALVE LIFTER</b>	
Inspection .....	07-06	Assembly .....	07-13
Installation .....	07-06	Cleaning and Inspection .....	07-13
Removal .....	07-05	Disassembly .....	07-13
		Installation .....	07-13
		Removal .....	07-13
		Testing .....	07-13

COMPONENT INDEX	Page	COMPONENT INDEX	Page
<b>VENTILATION SYSTEM - CRANKCASE</b>		<b>WATER PUMP</b>	
Cleaning .....	07-06	Installation .....	07-10
Description .....	07-02	Removal .....	07-10
Installation .....	07-06		
Removal .....	07-06		

## 1 DESCRIPTION

### ENGINE

The 429 (Fig. 1) and the 460 V-8 engines are a lightweight cast iron design and are basically the same with the exception of the bore and stroke. The compression ratio is 10.5 to 1 on both engines. These premium fuel engines have an Autolite 4300-4V carburetor and a hot and cold induction system with a tuned air cleaner.

### CRANKCASE VENTILATION SYSTEM

The 429 and 460 V-8 engines have a positive closed-type crankcase ventilation system. This system draws blow-by vapors from the crankcase and discharges them into the intake manifold to be burned in the combustion chambers of the engine, eliminating a major source of engine oil contamination. The positive closed-type crankcase ventilation system also prevents the discharge of any crankcase fumes to the atmosphere, as an air pollution control measure.

### EXHAUST EMISSION CONTROL SYSTEM

The 429 and the 460 V-8 engines were designed to produce a level of exhaust emissions at or below Federally established limits. All 460 CID engines and the 429 CID engines destined for California are equipped with the Thermactor Emission System. All other 429 CID engines are equipped with the IMCO Emission System.

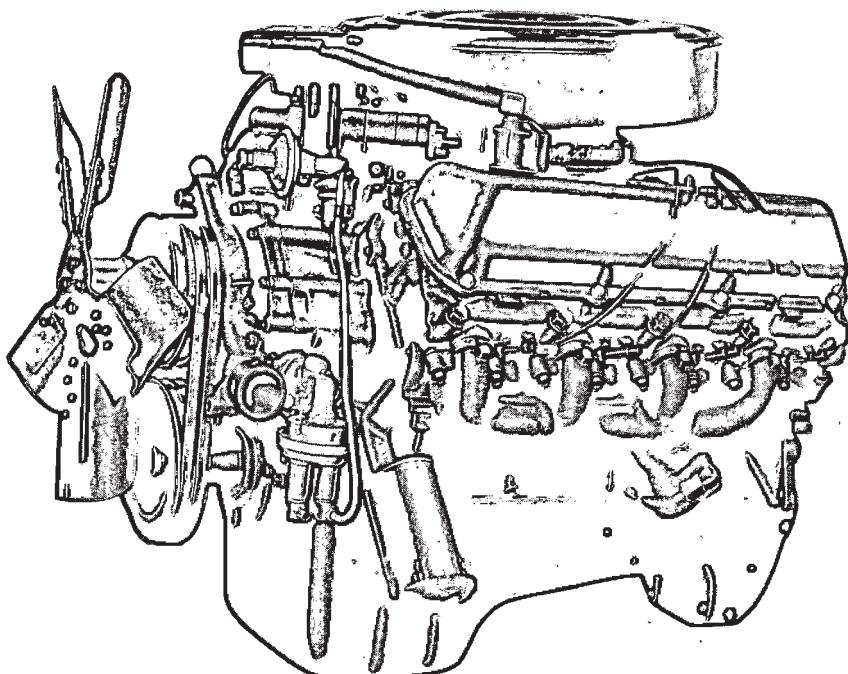


FIG. 1—3/4 Left Front View—429 CID

The use of an exhaust emission system reduces the amount of hydrocarbons and carbon monoxide formed in the combustion chambers by promoting more complete combustion. Carburetor and spark advance specifications give a more precise lean mixture with retarded spark to improve com-

bustion at low engine speeds where emissions have previously been highest. Limiter caps on the carburetor idle mixture adjusting screws prevent enriching the air-fuel mixture beyond the legal limits for emission control during adjustment.

## 2 IN-VEHICLE ADJUSTMENTS AND REPAIRS

When installing nuts or bolts that must be torqued (refer to Part 21-09 for torque specifications), oil the threads with light-weight engine oil. Do not oil threads that require oil-resistant or water-resistant sealer.

### ENGINE SUPPORTS

The front supports are located on each side of the cylinder block and the rear support is located at the transmission extension housing.

#### FRONT SUPPORT INSULATOR

Front supports (Figs. 2 through 4) are located on each side of the cylinder block. Following procedures apply to either support.

#### Ford, Mercury, Meteor, Mark III and Thunderbird

##### Removal

- Block rear wheels and set parking brake. Raise front of vehicle with a floor jack and install safety stands.
- Place a jack under the front area of the oil pan. Position a wood block between the jack and pan. Raise the jack just enough to support the engine.
- Remove the nut and through bolt that attaches the front support insulator to the lower support bracket (Fig. 2).
- Remove the bolts attaching sup-

port insulator and heat shield to the cylinder block. Replace the insulator on one side before proceeding to other support insulator.

##### Installation

- Position the support insulator and the heat shield to cylinder block (Fig. 2). Install and torque the attaching bolts to specifications.

2. Lower the engine, guiding front support insulator through bolt holes into alignment with support bracket and install the through bolt. Remove the floor jack and wood block. Torque the through bolt to specifications.

3. Raise the front of the vehicle and remove the safety stands. Lower the vehicle.

4. Remove the rear wheel blocks and release the parking brake.

#### Lincoln Continental

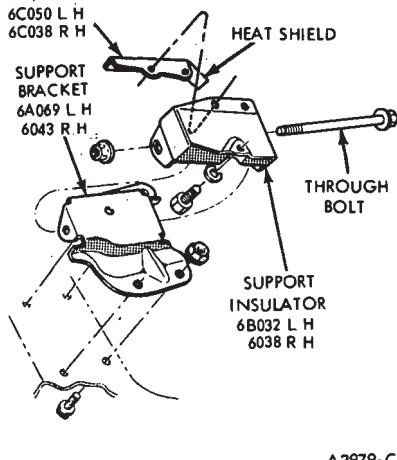
##### Removal

- Block rear wheels and set parking brake. Raise front of vehicle and install safety stands.

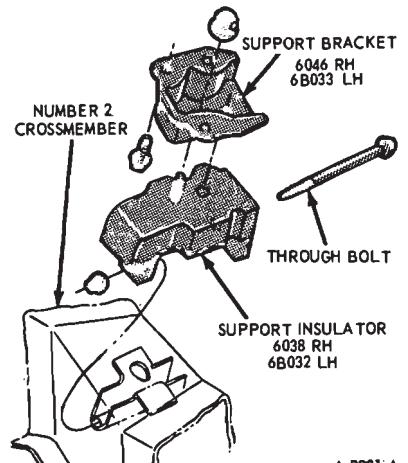
2. Remove the bolts that attach the support bracket to the cylinder block (Fig. 3).

3. Place a wood block on a jack under the front end of the oil pan. Raise the engine high enough (approximately 1 1/2 inches) to provide clearance to remove the support and not damage the radiator.

4. Remove the through bolts from the support insulator. Lift the insulator from the number 2 crossmember.



**FIG. 2—Engine Front Support—Ford, Mercury, Meteor, Mark III and Thunderbird**



**FIG. 3—Engine Front Support—Lincoln Continental**

- Remove the bracket-to-insulator attaching bolt and separate the units.

##### Installation

- Position the support bracket on the support insulator (Fig. 3) and install and torque the attaching nut to specifications.

2. Position the support on the number 2 crossmember. Install but do not tighten the through bolt.

3. Lower the jack until the cylinder block just contacts the support bracket.

4. Start the support bracket attaching bolts in the cylinder block then, lower and remove the jack from the oil pan.

5. Torque the through bolt and attaching bolts to specifications.

6. Remove the safety stands and lower the vehicle.

#### Fairlane and Montego

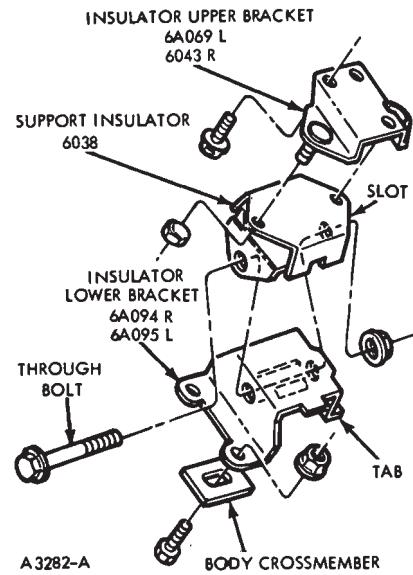
##### Removal

- Block rear wheels and set the parking brake. Raise the front of vehicle with a floor jack and install safety stands.

2. Remove the two nuts that attach the insulator upper bracket to the insulator (Fig. 4).

3. Place a jack under the front area of the oil pan. Position a wood block between the jack and oil pan. Raise the engine approximately 1 1/2 inches.

4. Remove the through bolt and lift insulator from lower bracket.



**FIG. 4—Engine Front Support—Fairlane-Montego**

**Installation**

1. Position the insulator on the lower bracket so notch in insulator engages tab on the bracket (Fig. 4), then install but do not tighten the through bolt at this time.

2. Lower the engine carefully and guide the studs of upper bracket into the insulator, then remove the jack.

3. Install and torque the two insulator nuts to specification.

4. Torque the through bolt to specification.

5. Remove the safety stands and lower the vehicle.

**ENGINE REAR SUPPORT INSULATOR****Ford, Mercury, Meteor,  
Thunderbird and Continental  
Mark III****Removal**

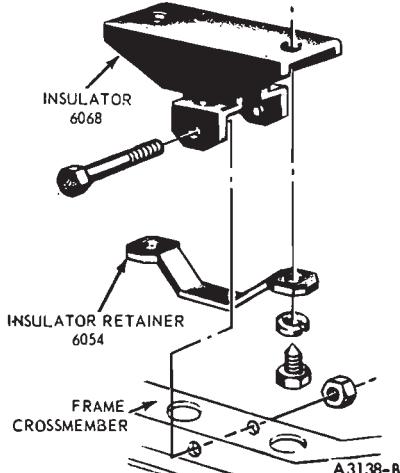
1. Remove the insulator assembly to crossmember attaching bolt(s) and nut(s) (Figs. 5 and 6).

2. Raise the transmission with a jack to obtain clearance at the transmission extension housing. Then remove the retainer and insulator assembly mounting bolts and washers. Remove the insulator assembly and the retainer.

**Installation**

1. Position the insulator assembly and retainer; then install the mounting bolts and lock washers. Torque the bolts to specifications.

2. Lower the transmission. Install



**FIG. 5—Engine Rear Support—Ford, Mercury and Meteor**

the insulator assembly to crossmember attaching bolt(s) and nut(s). Torque them to specifications.

**INTAKE MANIFOLD****REMOVAL**

1. Drain cooling system. Remove air cleaner and intake duct assembly.

2. Disconnect radiator upper hose at engine.

3. Disconnect heater hoses at intake manifold and water pump, and position out of way. Loosen water pump bypass hose clamp at intake manifold.

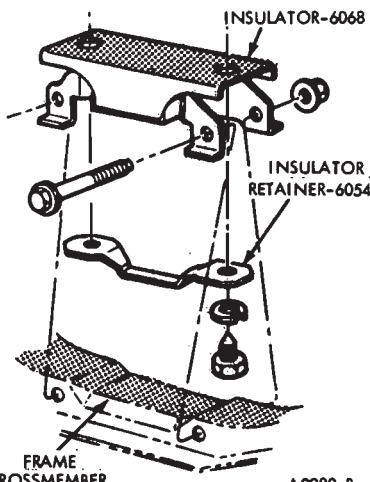
4. Disconnect positive crankcase ventilation valve and hose at right valve rocker arm cover. Disconnect all vacuum lines at rear of intake manifold and tag for proper installation.

5. Disconnect wires at spark plugs by twisting and pulling moulded caps. Remove wires from brackets on valve rocker arm covers. Disconnect coil high tension lead at coil and remove distributor cap and wires as an assembly.

6. Disconnect all distributor vacuum lines at carburetor and vacuum control valve and tag for proper installation. Remove distributor and vacuum lines as an assembly.

7. Disconnect accelerator linkage at carburetor. Remove speed control linkage bracket; if so equipped, from intake manifold and disconnect it from the carburetor. Remove bolts holding accelerator linkage bell crank, remove linkage springs, and position linkage out of way.

8. Disconnect fuel line at carburetor.



**FIG. 6—Engine Rear Support—Continental Mark III and Thunderbird**

tor.

9. Disconnect wiring harness at coil battery terminal, engine temperature sending unit, oil pressure sending unit, and other connections as necessary. Disengage wiring harness from three clips at left valve rocker arm cover bolts, and position wiring harness out of way.

10. Remove coil and bracket assembly.

11. Remove attaching bolts and nuts and remove intake manifold and carburetor as an assembly (Fig. 7). If necessary to pry manifold away from cylinder heads, do not damage gasket sealing surfaces.

12. Remove and discard intake manifold gaskets and seals.

13. If manifold is to be further disassembled (Fig. 8), remove coolant outlet housing, gasket, and thermostat. Remove automatic choke heat tubes, carburetor, spacer, and gaskets. Remove engine temperature sending unit. Discard all gaskets.

**CLEANING**

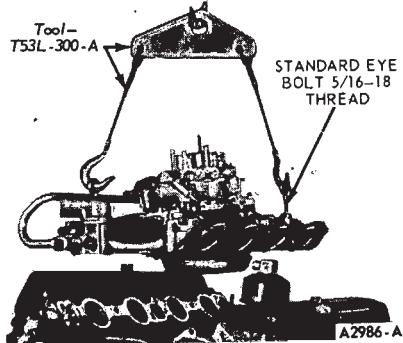
Remove all gasket material from the machined surfaces of the manifold. Clean the manifold in a suitable solvent and dry it with compressed air.

**INSPECTION**

Inspect the manifold for cracks, damaged gasket surfaces, or other defects that would make it unfit for further service. Replace all studs that are stripped or otherwise damaged. Remove all filings and foreign matter that may have entered the manifold as a result of repairs.

**INSTALLATION**

1. If intake manifold assembly was disassembled, install coolant outlet



**FIG. 7—Removing or Installing In-Take Manifold**

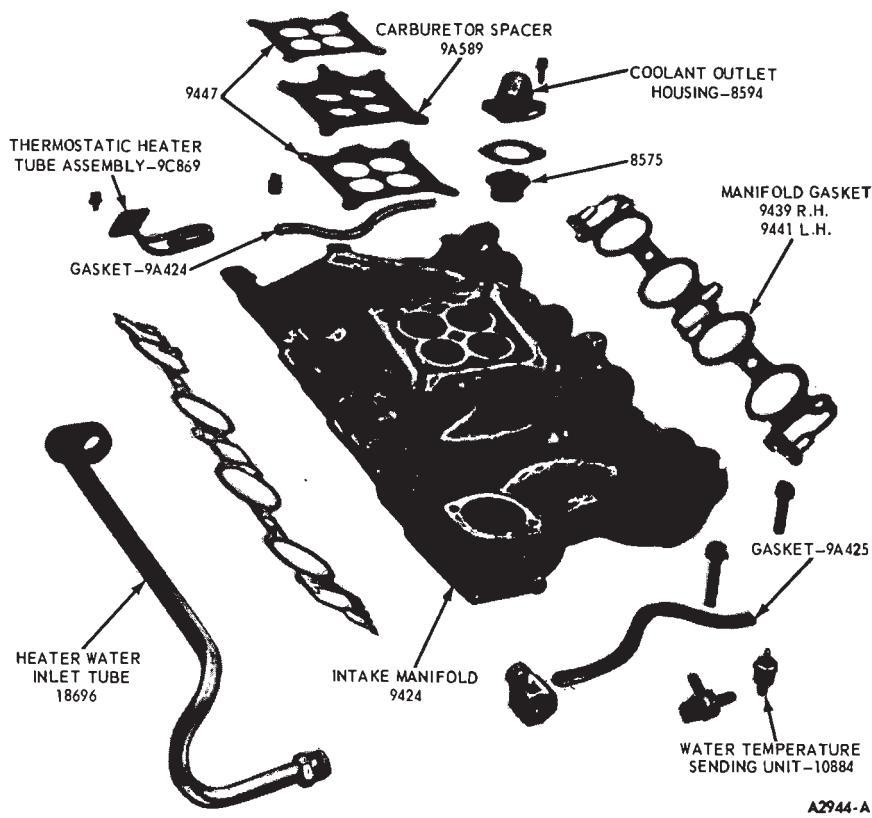


FIG. 8—Intake Manifold Disassembled

housing, new gasket, and thermostat. Install carburetor, spacer, new gaskets, and automatic choke heat tubes. Coat threads with electrical conductive sealer and install water temperature sending unit.

2. Clean mating surfaces of intake manifold, cylinder heads, and cylinder block. Use suitable solvent to remove all traces of oil.

3. Coat cylinder block seal surfaces with quick-drying adhesive sealer. Apply thin bead of non-hardening sealer at junction of cylinder block sealing surfaces and cylinder heads (4 places).

4. Position new intake manifold gaskets on cylinder heads, carefully aligning holes in gaskets with holes in cylinder heads. Coat underside of front and rear seals with quick-drying adhesive sealer and fit seals to cylinder block, aligning seal tabs in notches in gaskets. Apply bead of non-hardening sealer over four (4) junction points of seals and gaskets.

5. Carefully lower intake manifold into position over four (4) studs in ends of cylinder heads. When intake manifold is in place, run finger around seal area to be sure seals are in place. If seals have shifted, remove manifold and reposition seals.

6. Be sure intake manifold gaskets are properly aligned. Then install attaching bolts and nuts snugly to manifold. Torque bolts and nuts in sequence (Fig. 9) to specifications to compress gaskets and seals. Then repeat sequence, torquing bolts and nuts to same specifications.

7. Install water pump bypass hose to intake manifold fitting.

8. Connect radiator upper hose to coolant outlet housing.

9. Rotate crankshaft damper until No. 1 piston is at TDC at end of compression stroke. Position distributor in block with rotor at No. 1 firing position and points open. Install hold down clamp.

10. Connect heater hose at intake manifold and water pump.

11. Connect positive crankcase ventilation valve and hose to right valve rocker arm cover.

12. Connect fuel line to carburetor.

13. Install coil and bracket assembly to intake manifold.

14. Fit wiring harness into three (3) clips at inboard edge of left valve rocker arm cover and connect to all terminals.

15. Position accelerator linkage on manifold. Attach accelerator linkage bell crank. Attach speed control link-

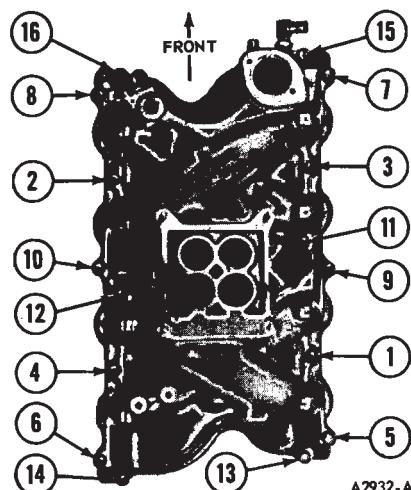


FIG. 9—Intake Manifold Torque Sequence

age bracket to intake manifold, if so equipped. Install linkage springs and connect linkage to carburetor.

16. Connect the vacuum lines to their respective ports at rear of intake manifold.

17. Secure distributor cap to distributor. Connect spark plug wires to spark plugs and fit wires into brackets on valve rocker arm covers. Connect coil high tension lead to coil.

18. Fill the cooling system.

19. Fill the power steering reservoir.

20. Start engine. Check and adjust ignition timing. Connect distributor vacuum lines to their respective parts.

21. Operate engine at fast idle and check for coolant and power steering fluid leaks. Bleed power steering system and refill reservoir as necessary. Recheck coolant level and refill as necessary.

22. Start the engine and allow it to reach normal operating temperature, then retorque the manifold attaching nuts and bolts to specification.

23. Check and adjust carburetor idle speed and mixture (Group 23) as required. Install air cleaner and intake duct assembly.

## EXHAUST MANIFOLDS

### REMOVAL

- If removing right exhaust manifold, remove air cleaner and intake duct assembly.

- Disconnect exhaust manifold(s) at resonator or muffler inlet pipe(s).

- Remove attaching bolts and washers, and remove exhaust manifold(s) and lifting bracket(s).

## CLEANING

Remove all gasket material from the manifolds.

## INSPECTION

Inspect the cylinder head joining flanges of the exhaust manifold(s) for evidence of exhaust gas leaks.

Inspect the manifold(s) for cracks, damaged gasket surfaces, or other defects that would make them unfit for further service.

## INSTALLATION

- Clean mating surfaces of exhaust manifold(s) and cylinder head(s). Clean mounting flange of manifold(s) and resonator inlet pipe(s). Apply light film of graphite grease to exhaust manifold(s) and cylinder head port areas.

- Position exhaust manifold(s) on cylinder head(s). Install attaching bolts and washers, starting at fourth bolt hole from front of each manifold. Position lifting bracket under bolts at third exhaust port from front of engine. On right exhaust manifold, install shoulder stud(s) for air intake heat shroud at first and sixth bolt holes from front of manifold (Fig. 10). Torque bolts to specifications, working from center of manifold to both ends.

- Place new gasket(s) on resonator or muffler inlet pipe(s). Position inlet pipe(s) to manifold(s). Install attaching nuts and torque to specifications.

- Install air cleaner and intake duct assembly, if removed.

- Start engine and check for exhaust leaks.

## CRANKCASE VENTILATION SYSTEM

### REMOVAL

- Remove ventilation system air intake hose from air cleaner and oil filler cap. Remove oil filler cap.

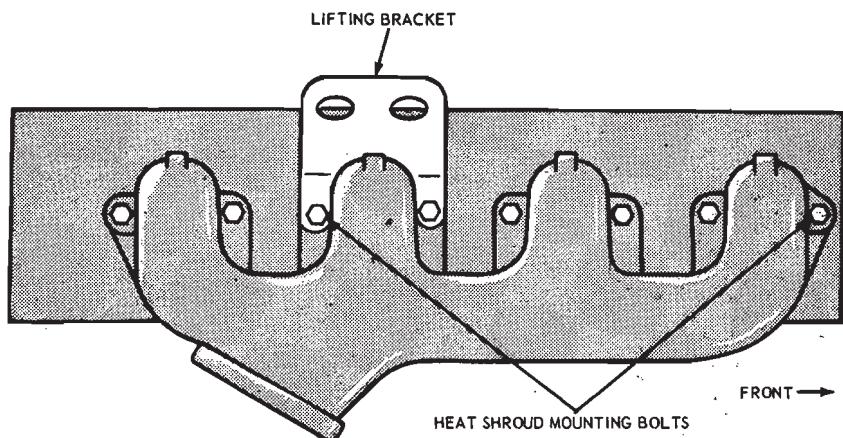
- Remove air cleaner and intake duct assembly.

- Disconnect crankcase vent hose at carburetor spacer and regulator valve.

- Pull regulator valve out of mounting grommet in right valve rocker arm cover.

### CLEANING

Wash the oil filler cap in a low-volatility, petroleum-base solvent.



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**FIG. 10—Right Exhaust Manifold Installation**

Shake the cap dry. **Do not dry the oil filler cap with compressed air, since air pressure may damage the filter element.**

Clean the rubber hoses and associated hardware with the same type of solvent and dry them with compressed air.

Clean the crankcase ventilation system connection on the carburetor spacer by probing with a flexible wire or bottle brush.

**Do not attempt to clean the regulator valve.** It should be replaced at the specified mileage interval or when test indicates it is defective.

## INSTALLATION

- Insert regulator valve into mounting grommet in right valve rocker arm cover.

- Connect vent hose to carburetor spacer and regulator valve.

- Install air cleaner and intake duct assembly.

- Install oil filler cap. Install ventilation system air intake hose to air cleaner and oil filler cap.

## CYLINDER HEADS

### REMOVAL

- Remove intake manifold and carburetor as an assembly, following procedure under Intake Manifold Removal.

- Disconnect resonator or muffler inlet pipe(s) at exhaust manifold(s).

- Loosen air conditioning compressor drive belt, if so equipped.

- Loosen alternator attaching bolts and remove bolt attaching alter-

nator bracket to right cylinder head.

- If equipped with air conditioning, isolate compressor at service valves and remove valves and hoses from compressor. Remove nuts attaching compressor support bracket to water pump. Remove bolts attaching compressor to upper mounting bracket and position compressor out of way. Remove compressor upper mounting bracket from cylinder head.

- If not equipped with air conditioning, remove bolts attaching power steering reservoir bracket to left cylinder head. Position reservoir and bracket out of way.

- Remove valve rocker arm covers. Loosen rocker arm stud nuts and turn rocker arms to one side. Remove push rods in sequence (Fig. 11) so they can be installed in their original positions.

- Remove cylinder head attaching bolts. Lift cylinder heads and exhaust manifolds as assemblies from cylinder block with a hoist. **If necessary to loosen cylinder head gasket seal, pry at forward corners of cylinder heads against casting bosses provided on cylinder block. Do not damage machined surfaces of head or block. Discard cylinder head gasket.**

- If disassembly or machining of cylinder head is required, remove exhaust manifold, gasket and valve rocker arms.

## INSTALLATION

- Clean cylinder head, intake manifold, valve rocker arm cover, and cylinder block gasket surfaces. If cylinder head was removed for cylinder head gasket replacement, check flat-

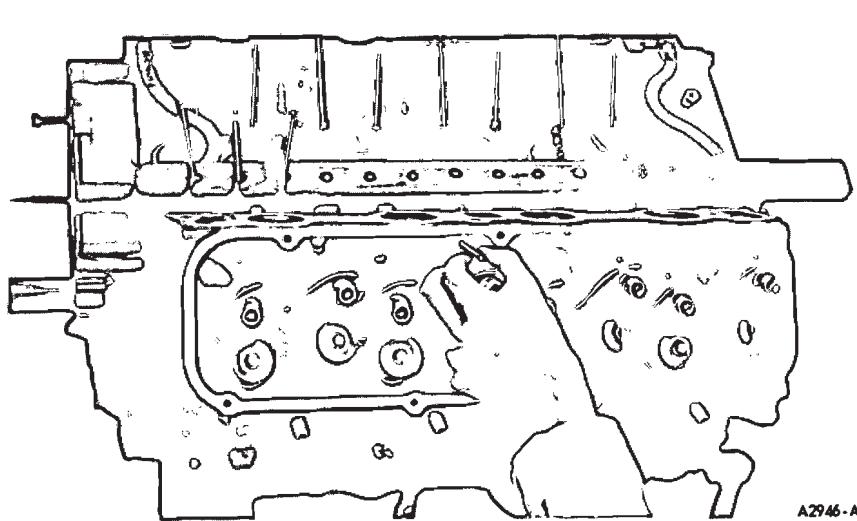


FIG. 11—Removing Valve Push Rod

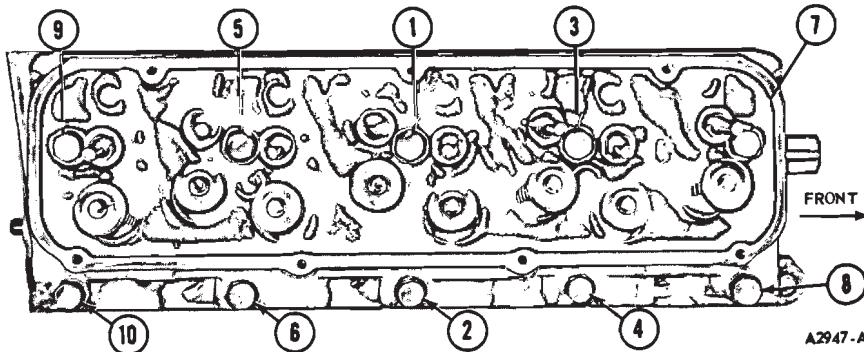


FIG. 12—Cylinder Head Bolt Torque Sequence

ness of cylinder head and block gasket surfaces. If exhaust manifold was removed, coat cylinder head and manifold port areas with film of graphite grease and install manifold and gasket to cylinder head.

2. Place two (2) long cylinder head attaching bolts in two rear lower bolt holes of left cylinder head. Place a long cylinder head attaching bolt in rear lower bolt hole of right cylinder head. Use rubber bands to retain bolts in position until cylinder heads are installed.

3. Position new cylinder head gaskets on block over dowels. Place cylinder heads on block, guiding exhaust manifold studs into resonator or muffler inlet pipe connections, and install remaining attaching bolts (longer bolts in lower row of bolt holes). Tighten all cylinder head attaching bolts in sequence (Fig. 12) in three steps: first to 75 ft-lbs, then to 105 ft-lbs, and finally to specifications.

**When this procedure is used, it is not necessary to retorque bolts after extended operation.**

4. Clean and inspect push rods, one

at a time. Clean the oil passage in the push rods with a suitable solvent, and blow out with compressed air.

5. Install push rods in original positions. Apply Lubriplate to valve stem tips.

6. Apply Lubriplate to fulcrum seats and sockets. Turn rocker arms, into position (or install rocker arms, fulcrum seats, and stud nuts, if removed) and tighten stud nuts enough to hold rocker arms in position. Be sure lower ends of push rods remain seated in valve lifters.

7. Torque resonator or muffler inlet pipe stud nuts to specifications.

8. Install intake manifold and carburetor assembly, following procedure under Intake Manifold Installation.

9. Perform valve clearance adjustment, as detailed under Valve Clearance Adjustment.

10. If equipped with air conditioning, install compressor upper mounting bracket to left cylinder head. Attach compressor to upper mounting bracket. Attach power steering reservoir and compressor mounting bracket to left cylinder head and water

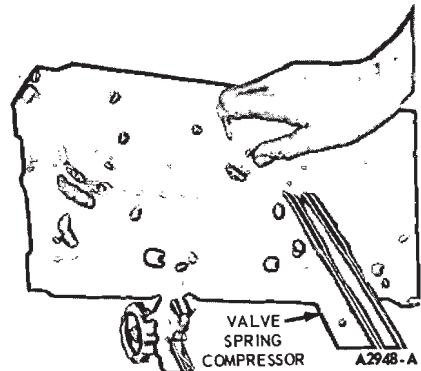


FIG. 13—Compressing Valve Spring—On Bench

pump. Connect service valves and hoses to compressor.

If not equipped with air conditioning, attach power steering reservoir bracket to left cylinder head.

11. Apply oil-resistant sealer to one side of new valve rocker arm cover gaskets. Lay cemented side of gaskets in place in covers. Install covers.

12. Install bolt attaching alternator bracket to right cylinder head. Adjust alternator drive belt tension to specifications and tighten alternator attaching bolts.

13. If equipped with air conditioning, adjust compressor drive belt tension to specifications and tighten attaching bolts.

14. Fill radiator and power steering reservoir, as necessary.

15. Start engine and check for leaks.

16. Check and adjust carburetor idle speed and mixture (Group 23) as required.

17. If equipped with air conditioning, evacuate compressor and partially charge system with refrigerant (Group 34).

## DISASSEMBLY

1. Remove rocker arm stud nuts, fulcrum seats, and rocker arms. Remove exhaust manifolds and spark plugs.

2. Clean carbon from combustion chambers before removing valves.

3. Compress valve springs (Fig. 13). Remove spring retainer locks and release springs. Remove retainers, springs, stem seals, and valves. Discard stem seals.

## CLEANING AND INSPECTION

Clean and inspect cylinder head(s)

and related components, using pertinent procedures in Part 23-01.

## REPAIRS

Refer to Part 23-01, Section 2 for repair procedures for cylinder heads and valves. Refer to Valve Rocker Arm Assembly for rocker arm stud replacement procedure.

## ASSEMBLY

Lubricate all valves, valve stems and valve guides with heavy oil MS. The valve tips are to have Lubriplate or equivalent applied. The lubricant is to be applied before installation.

1. Install each valve in port from which it was removed or to which it was fitted. Install new stem seal to each valve.

2. Set valve spring and retainer over valve stem. Compress spring (Fig. 13) and install retainer locks.

3. With dividers, measure assembled height of valve spring from surface of spring pad on cylinder head to underside of spring retainer (Fig. 14). Check dividers with accurate scale. If assembled height exceeds specifications, install spacer(s) below spring to reduce height to recom-

mended dimension. Reducing assembled height below specifications can cause spring breakage and rapid wear of cam lobe.

4. Coat the fulcrum seats and sockets with Lubriplate. Make certain that the rocker arm stud nuts are in a serviceable condition (Fig. 15) before installing them. If the seat is cracked or deformed the valve spacing will be insufficient and could possibly cause burned valves. Install rocker arms, fulcrum seats, and stud nuts. Turn stud nuts down only about two turns to facilitate push rod installation when cylinder head is installed.

5. Install exhaust manifolds and spark plugs.

## VALVE SPRING, RETAINER AND STEM SEAL

Broken valve springs or defective valve stem seals or retainers may be replaced without removing the cylinder head if valve or valve seat is not damaged.

Valve Spring Compressor Tool T-62F-6565-A must be modified for use on the 429 or 460 V-8. File or grind as necessary to provide 3/4 inch clearance, 3/8 inch into throat of tool. Also file or grind 3/8 inch clearance rest of way into throat of tool

(see insert, Fig. 16). Modified tool can be used on other engines with stud-mounted rocker arms.

## REMOVAL

1. If defective spring, retainer, or seal is on right side of engine, remove air cleaner and intake duct assembly. Remove crankcase ventilation system regulator valve and hose from right valve rocker arm cover.

- If defective spring, retainer, or seal is on left side of engine, remove oil filler cap and ventilation hose from left valve rocker arm cover and position out of way.

2. Remove valve rocker arm cover(s) and applicable spark plug(s).

3. Remove valve rocker arm stud nuts, fulcrum seats, rocker arms, and push rods from affected cylinder(s).

4. Install air line with adapter in spark plug hole. Turn on air supply to hold valves closed.

5. Install stud nut and compress valve spring with modified tool (Fig. 16). Remove retainer locks, spring retainer, and spring. Remove and discard valve stem seal (Fig. 17).

If air pressure fails to hold valve in closed position, valve damage affecting sealing is indicated. Remove and inspect cylinder head assembly.

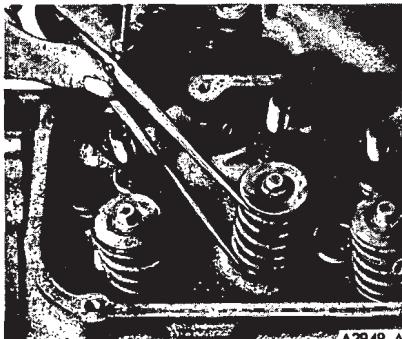


FIG. 14—Measuring Valve Spring Assembled Height

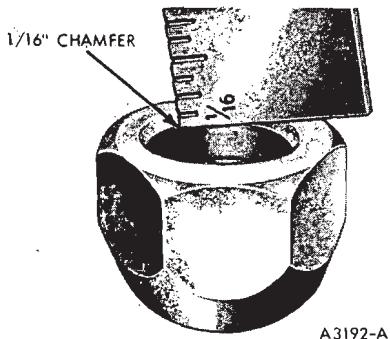


FIG. 15—Measuring Chamfer on Valve Rocker Arm Stud Nut

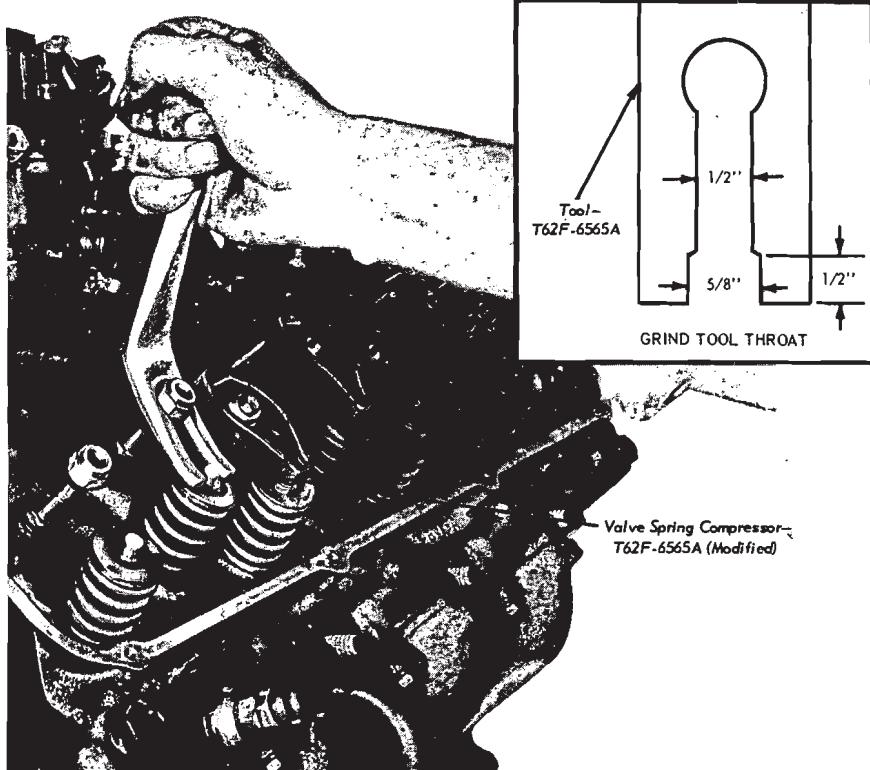


FIG. 16—Compressing Valve Spring—In Chassis

6. Wrap rubber band, tape or string around end of valve stem to prevent valve from dropping into cylinder when air pressure in cylinder is shut off if piston is at bottom of cylinder. Shut off air pressure.

7. Inspect valve stem for damage.

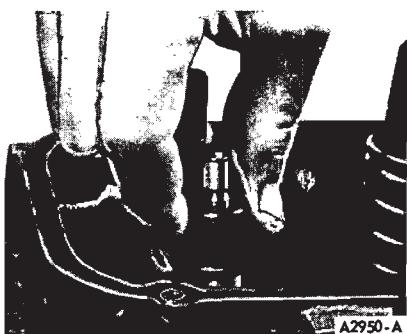


FIG. 17—Removing or Installing Valve Stem Seal

Tool—6513-AC



FIG. 18—Checking Valve Clearance

With No. 1 at TDC at end of compression stroke make a chalk mark at points B and C approximately 90 degrees apart.

Rotate valve, checking tip for eccentric movement. Move valve up and down through normal travel in valve guide and check for binding. If valve is damaged, cylinder head must be removed for repairs.

### INSTALLATION

1. If valve proves satisfactory, hold valve closed and turn on air pressure in cylinder.

2. Install new valve stem seal (Fig. 17). Set spring and retainer over valve stem. Compress valve spring with modified tool (Fig. 16) and install retainer locks. Release spring and remove tool and stud nut.

3. Shut off air pressure and remove air line and adapter. Install spark plug.

4. Apply Lubriplate to tip of valve stem and each end of push rod. Install push rod. Be sure lower end of push rod is seated in valve lifter.

5. Lubricate fulcrum seats and sockets with heavy oil MS. Install rocker arms, fulcrum seats, and stud nuts.

6. Adjust valve clearance as detailed under Valve Clearance, Checking and Adjustment Procedure.

7. Clean and install valve rocker arm cover(s). Connect spark plug wires.

8. On a right valve rocker arm cover, install air cleaner and duct assembly, crankcase ventilation regulator valve and hose. On a left valve rocker arm cover, install the oil filler cap and ventilation hose.

### VALVE CLEARANCE—CHECKING AND ADJUSTMENT PROCEDURE

The valve arrangement on the left

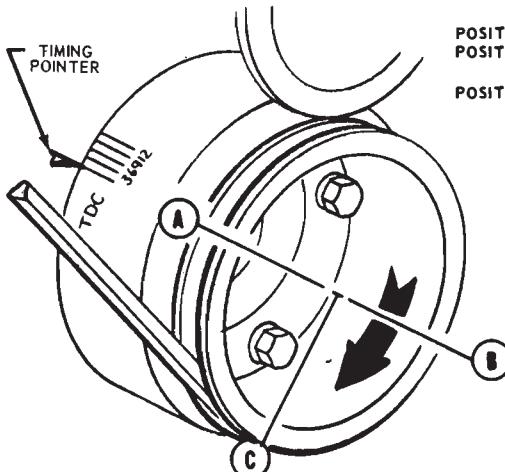


FIG. 19—Position of Crankshaft for Checking Valve Clearance and Installing Rocker Arms

bank is E-I-E-I-E-I-E-I and on the right bank is I-E-I-E-I-E-I-E.

A 0.060-inch shorter push rod or a 0.060-inch longer push rod are available for service to provide a means of compensating for dimensional changes in the valve mechanism. Refer to the Master Parts List or the specifications for the pertinent color code.

Valve stem to valve rocker arm clearance should be within specifications with the hydraulic lifter completely collapsed. Repeated valve reconditioning operations (valve and/or valve seat refacing) will decrease the clearance to the point that if not compensated for, the hydraulic valve lifter will cease to function and the valve will be held open.

To determine whether a shorter or a longer push rod is necessary, make the following check:

1. Disconnect the brown lead (I terminal) and the red and blue lead (S terminal) at the starter relay. Install an auxiliary starter switch between the battery and S terminals of the Starter relay, or solenoid on a Lincoln Continental or Mark III. Crank the engine with the ignition switch OFF until the No. 1 piston is on TDC after the compression stroke.

2. With the crankshaft in the positions designated in Steps 3, 4, and 5, position the hydraulic lifter compressor tool on the rocker arm. Slowly apply pressure to bleed down the hydraulic lifter until the plunger is completely bottomed (Fig. 18). Hold the lifter in this position and check the available clearance between the rocker arm and the valve stem tip with a feeler gauge.

If the clearance is less than specifications, install an undersize push rod.

POSITION A — No. 1 at TDC at end of compression stroke.

POSITION B — Rotate the crankshaft 180 degrees (one half revolution) clockwise from POSITION A.

POSITION C — Rotate the crankshaft 270 degrees (three quarter revolution) clockwise from POSITION B.

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If the clearance is greater than specifications, install an oversize push rod.

3. With the No. 1 piston on TDC at the end of the compression stroke as shown in POSITION A, Fig. 19, check the following valves:

No. 1 Intake No. 1 Exhaust

No. 7 Intake No. 5 Exhaust

No. 8 Intake No. 4 Exhaust

4. After checking the spacing on these valves, rotate the crankshaft to POSITION B as shown in Fig. 19, then check the following valves:

No. 4 Intake No. 2 Exhaust

No. 5 Intake No. 6 Exhaust

5. After checking the spacing on these valves, rotate the crankshaft to POSITION C as shown in Fig. 19, and check the following valves:

No. 2 Intake No. 3 Exhaust

No. 3 Intake No. 7 Exhaust

No. 6 Intake No. 8 Exhaust

## WATER PUMP

### REMOVAL

1. Drain cooling system.

2. Remove bolts attaching fan assembly to water pump. Remove screws attaching radiator shroud to radiator, and remove shroud and fan.

3. If vehicle is equipped with air conditioning, loosen compressor drive belt idler pulley and remove drive belt.

4. Loosen alternator mounting bolts and remove alternator drive belt. Remove water pump pulley.

5. Remove bolts attaching compressor bracket to water pump, if so equipped.

6. Loosen alternator bracket at right cylinder head and cylinder block, and remove bolts attaching bracket to water pump.

7. Disconnect radiator lower hose, heater return hose and bypass hose at water pump.

8. Remove remaining water pump attaching bolts and remove water pump from cylinder front cover. Remove backing plate from water pump. Discard gaskets.

### INSTALLATION

**Before reinstalling water pump, check carefully for damage. Replace a damaged water pump with a new pump.**

1. Remove any gasket material from water pump, cylinder front cover and backing plate mating surfaces.

2. Position new gaskets, coated on both sides with water-resistant sealer,

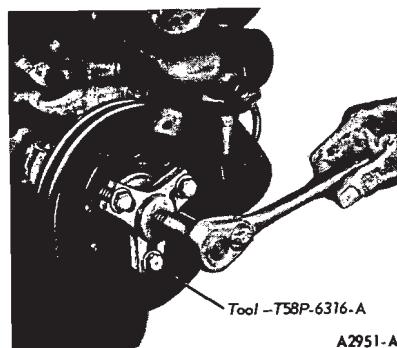


FIG. 20—Removing Crankshaft Vibration Damper

and separator plate to water pump.

3. Position water pump on cylinder front cover and install only those bolts not used to attach compressor bracket (if installed) and alternator bracket to water pump. Torque bolts to specifications.

4. Connect radiator lower hose, heater return hose, and bypass hose to water pump.

5. Install two bolts attaching alternator bracket to water pump and torque to specifications. Tighten alternator bracket bolts at right cylinder head and cylinder block.

6. Install compressor lower bracket to water pump. Torque bolts to specifications.

7. Install pulley to water pump shaft. Set compressor drive belt (if used) and alternator drive belt in position. Adjust drive belts(s) to specified tension and tighten bolts.

8. Place fan assembly inside radiator shroud, and set fan and shroud in position in vehicle. Attach shroud to radiator with screws. Install bolts attaching fan assembly to water pump.

9. Fill and bleed the cooling system. Run engine until normal operating temperature is reached and check for leaks.

## CYLINDER FRONT COVER AND TIMING CHAIN

### REMOVAL

Cylinder front cover oil seal replacement is recommended whenever the cover has been removed.

1. Drain cooling system and crankcase.

2. Remove bolts attaching fan to water pump shaft. Remove screws attaching radiator shroud to radiator. Remove fan and radiator shroud.

3. Disconnect radiator upper and lower hoses at engine. Disconnect oil cooler lines at radiator.

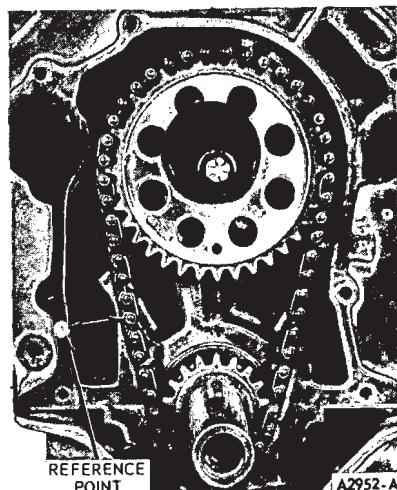


FIG. 21—Timing Chain Deflection

4. Remove radiator upper support and remove radiator.

5. Loosen alternator attaching bolts to relieve tension on drive belt. If equipped with air conditioning, loosen compressor idler pulley. Remove drive belts with water pump pulley.

6. Remove bolts attaching compressor support water pump and compressor, and remove compressor support (if so equipped).

7. Remove bolt and washer attaching crankshaft damper. Remove crankshaft damper with Tool T58P-6316-B (Fig. 20). Remove Woodruff key from crankshaft.

8. Remove power steering pump and place it to one side being careful not to lose the lubricant.

9. Loosen bypass hose at water pump. Disconnect heater return tube at water pump.

10. Disconnect and plug fuel inlet line at fuel pump. Disconnect fuel line to carburetor at fuel pump. Remove fuel pump.

11. Remove bolts attaching cylinder front cover to cylinder block. Using a thin blade knife cut the oil pan seal flush with cylinder block face prior to separating the cover from the cylinder block. Remove cylinder front cover and water pump as an assembly. Discard cylinder front cover gasket and oil pan seal.

12. If new cylinder front cover is to be installed, remove water pump and install it and a new gasket on the new front cover.

13. Check timing chain deflection by rotating the crankshaft in a counterclockwise direction to take up the slack on the left side of the chain. (All directions are as viewed from the front of the engine).

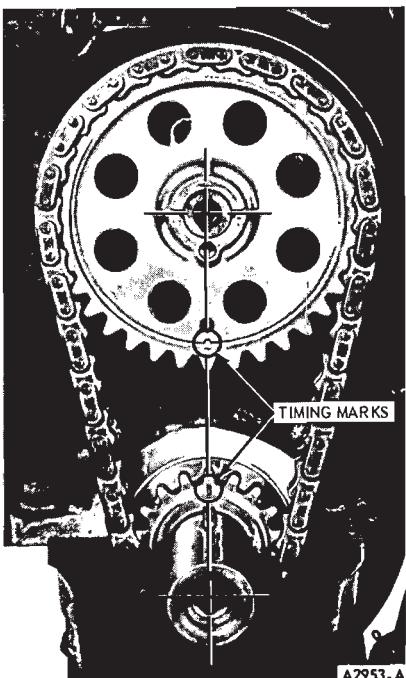


FIG. 22—Aligning Timing Marks

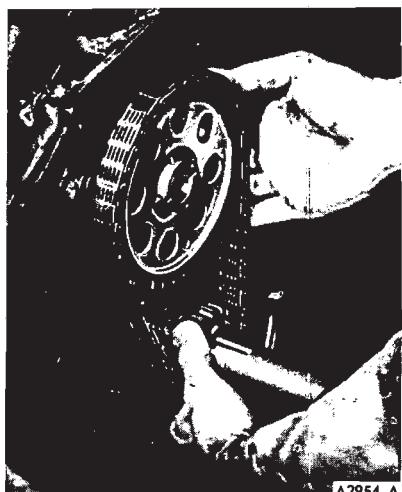


FIG. 23—Removing or Installing Timing Chain

Establish a reference point on the block and measure from this point to the left side of the chain as shown in Fig. 21.

Rotate the crankshaft in the opposite direction to take up the slack on the right side of the chain. Force the left side of the chain out with the fingers and measure the distance between the reference point and the chain. The deflection is the difference between the two measurements.

If the deflection exceeds specifications, replace the timing chain and sprockets.

14. If the timing chain and sprocket are to be removed, crank the en-



FIG. 24—Aligning Cylinder Front Cover

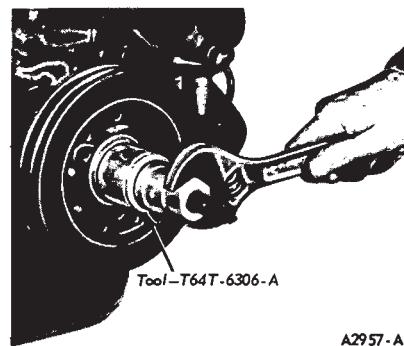


FIG. 25—Installing Crankshaft Vibration Damper

gine until timing marks on sprockets are as shown in Fig. 22.

15. Remove camshaft sprocket cap screw, washer, and fuel pump eccentric. Slide timing chain and sprockets forward, and remove as an assembly (Fig. 23).

#### CLEANING AND INSPECTION

Refer to Part 21-01, Section 3 for cleaning and inspection procedures.

#### INSTALLATION

1. Assemble the timing chain and sprockets so sprocket timing marks point directly toward each other as shown in Fig. 22. Install the chain and sprockets as an assembly to crankshaft and camshaft. Verify proper alignment of timing marks after installation.

2. Install the fuel pump eccentric, camshaft sprocket cap screw and washer. Torque cap screw to specifications. Lubricate timing chain with engine oil.

3. Coat the gasket surface of the oil pan with sealer, cut and position the required sections of a new seal on the oil pan, apply sealer at the corners.

4. Coat the gasket surfaces of the block and cover with sealer, and position a new gasket on the block.

5. Position the cylinder front cover on the cylinder block. Use care when installing the cover to avoid seal damage or possible mislocation.

6. Install the cylinder front cover to seal alignment tool into proper position. It may be necessary to force the cover downward in a manner to slightly compress the pan seal. This operation can be facilitated by using a suitable tool at the attaching bolt hole locations.

7. Coat the threads of the attaching bolts with oil-resistant sealer and install the screws.

8. While pushing in on the alignment tool, torque the oil pan to cover attaching bolts to specifications (Fig. 24). Remove alignment tool. Torque the cover to cylinder block attaching screws.

9. Apply white lead and oil mixture to front of crankshaft for damper installation.

10. Install crankshaft damper Woodruff key and install crankshaft damper (Fig. 25). Install damper attaching screw and washer.

11. Coat new fuel pump gasket with oil-resistant sealer and place on fuel pump. Install fuel pump. Connect fuel lines to fuel pump.

12. Install the power steering pump.

13. Install compressor support bracket to compressor and water pump, if so equipped.

14. Install water pump pulley and all drive belts.

15. Position radiator to lower support, position upper support to radiator, and install attaching bolts. Connect radiator upper and lower hoses at engine. Connect oil cooler lines.

16. Place fan assembly inside radiator shroud and set in position in vehicle. Install screws attaching shroud to radiator. Install fan assembly to water pump shaft.

17. Adjust belt tension to specifications. Tighten alternator attaching bolts and compressor idler pulley, if so equipped.

18. If any of the coolant entered the oil pan when separating the cylinder front cover from the block, the crankcase oil should be drained and refilled with the proper grade and quantity of engine oil before starting

the engine.

19. Fill and bleed the cooling system. Fill the crankcase to the correct level with the recommended oil.

20. Run engine at fast idle and check for coolant and oil leaks. Adjust ignition timing.

#### FRONT OIL SEAL

**Replacement of the front oil seal is recommended whenever the cylinder front cover is removed.**

1. Drive out the old seal with a pin punch. Clean the seal recess in the cylinder front cover.

2. Coat a new seal with grease. In-

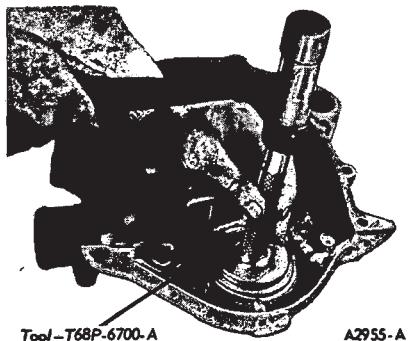


FIG. 26—Installing Crankshaft Front Oil Seal

stall the seal with Tool T68P-6700-A (Fig. 26). After installation, be sure seal spring remains in proper position.

#### CAMSHAFT

The camshaft and related parts are shown in Fig. 27.

#### REMOVAL

1. Remove timing chain and sprockets, following procedure under Cylinder Front Cover and Timing Chain. Check timing chain deflection before removal.

2. Remove the intake manifold and carburetor as an assembly, following the instructions under Intake Manifold.

3. Remove valve rocker arm covers. Back off all rocker arm stud nuts, turn rocker arms sideways, and remove the push rods in sequence (Fig. 11).

4. Remove the valve lifters with a magnet and place them in a rack in sequence. If the lifters are stuck in bores, use plier-type tool (T52T-6500-DJD or 6500-D) to remove them. Rotate the lifter back and forth to loosen it from gum or varnish deposits.

5. Remove the bolts attaching the air conditioning condenser to the chassis, if so equipped, and carefully move the condenser to rest on the left fender. Secure it in this position.

6. Remove the grille.

7. Remove the camshaft thrust plate attaching bolts, and carefully remove the camshaft from the front of engine. **Do not damage the camshaft bearings.**

#### CLEANING AND INSPECTION

Refer to Part 21-01, Section 3 for cleaning and inspection procedures.

#### REPAIRS

Refer to Part 21-01 for repair procedure.

#### INSTALLATION

1. Oil the camshaft journals and apply Lubriplate or equivalent to the cam lobes. Carefully slide camshaft into position.

2. Install camshaft thrust plate. Check camshaft end play, following procedure in Part 21-01. If end play is excessive, replace the camshaft thrust plate.

3. Install the grille center support and air conditioning condenser, if so equipped.

4. Install timing chain, sprockets, and cylinder front cover as detailed under, Cylinder Front Cover and Timing Chain.

5. Position the radiator in the vehicle and install the radiator upper support to secure radiator. Connect the radiator lower hose and oil cooler lines.

6. Lubricate the lifters and lifter bores with heavy oil MS before installing them. Lubricate the push rod ends with Lubriplate or equivalent. Install the valve lifters and push rods in their original positions.

7. Install intake manifold and carburetor, following the procedure under Intake Manifold.

8. Rotate the crankshaft damper until No. 1 piston is at TDC at the end of compression stroke. Position the distributor in the block with the rotor at No. 1 firing position and points just starting to open. Install the hold down clamp.

9. Apply Lubriplate or equivalent to valve stem tips. Position rocker arms over push rods. Adjust valve clearance.

10. Clean the valve rocker arm covers and cylinder head gasket surfa-

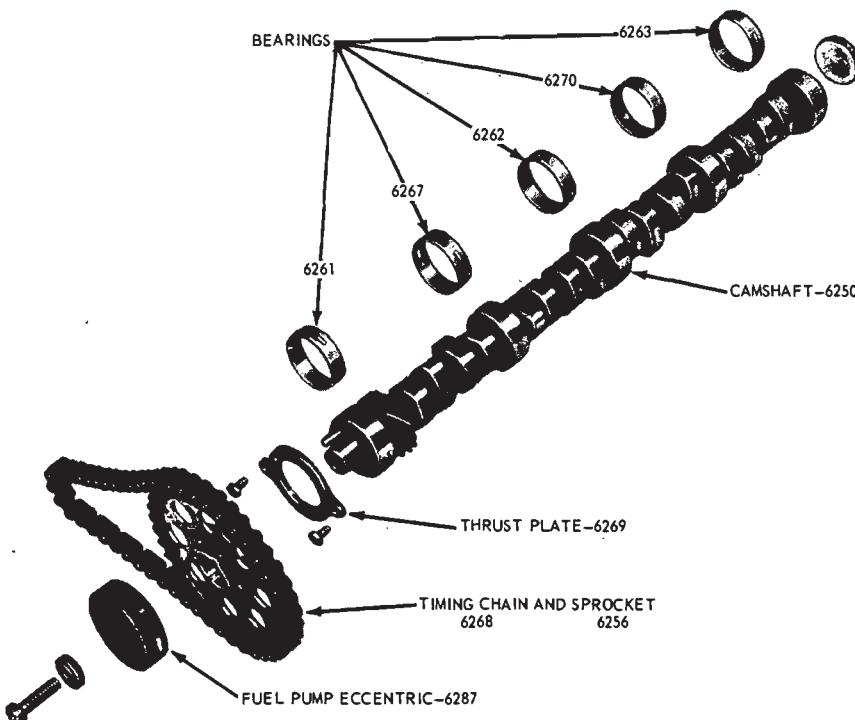


FIG. 27—Camshaft and Related Parts

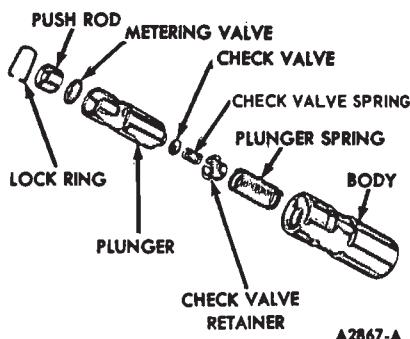


FIG. 28—Type I Hydraulic Valve Lifter

ces. Apply oil-resistant sealer to one side of the new cover gaskets. Lay the cemented side of gaskets in place in the covers.

11. Position the covers on the cylinder heads and make sure that gaskets seat evenly. Install cover attaching bolts and torque to specifications. Two minutes later, torque bolts to same specifications.

12. Connect the radiator upper hose. Connect heater hose at intake manifold and at water pump.

13. Connect the fuel line to carburetor.

14. Install the coil and bracket assembly to intake manifold.

15. Install the accelerator linkage. Install the speed control linkage, if so equipped.

16. Engage engine wiring harness in clips on left cylinder head and connect all wire terminals. Connect engine vacuum lines to their original outlets on the fitting at rear of the intake manifold. Connect positive crankcase ventilation valve and hose to right valve rocker arm cover.

17. Install the distributor cap and connect the coil and spark plug wires.

18. Place the water pump pulley and drive belts in position. Place the fan assembly in the radiator shroud and set in position. Install screws attaching shroud to the radiator. Install the fan assembly to water pump shaft.

19. Adjust the tension of drive belts to specifications and tighten attaching screws.

20. Fill and bleed the cooling system and power steering reservoir. Run engine at fast idle and check for leaks.

21. Adjust the ignition timing and connect distributor vacuum line.

22. Check and adjust the carburetor idle speed and mixture as required after engine temperature has stabilized. Adjust transmission linkage, if

necessary. Install the air cleaner and intake duct.

#### CAMSHAFT REAR BEARING BORE PLUG

##### REMOVAL

1. Remove the transmission from the vehicle as detailed in Group 6 or 7.

2. Remove flywheel and engine rear cover plate, following procedure under Flywheel Removal.

3. Replace the plug as detailed in Part 21-01.

##### INSTALLATION

1. Install the engine rear cover plate and flywheel, following procedure under Flywheel Installation.

2. Install the transmission as detailed in Group 6 or 7.

#### VALVE LIFTER

The following procedure is applicable for removing one or all of the valve lifters. Before replacing a hydraulic valve lifter for noisy operation, be sure the noise is not caused by improper valve clearance or by worn rocker arms and/or push rods.

##### REMOVAL

1. Remove intake manifold and carburetor as an assembly, following instructions under Intake Manifold.

2. Remove the valve rocker arm covers. Loosen the rocker arm stud nuts and turn rocker arms to one side.

3. Remove the push rods in sequence.

4. Remove the valve lifters with a magnet. Place them in a rack in sequence. If the lifters are stuck in bores, use plier-type tool (T52T-6500-DJD) to remove them. Rotate lifter back and forth to loosen them from gun or varnish deposits.

**Internal parts of hydraulic valve lifters are matched sets. Do not intermix parts. Keep assemblies intact before and after cleaning.**

##### TESTING

Refer to Part 21-01 for testing procedure.

##### INSTALLATION

1. Clean the valve lifters. Lifters and bores are to be lubricated with

heavy oil MS before installation. Install the lifters in their original bores. Check any new lifter for free fit in bore to which it is to be installed.

2. Install push rods in original positions. Apply Lubriplate or equivalent to valve stem tips, push rod ends and guides.

3. Position the rocker arms over the push rods. Adjust valve clearance.

4. Install valve rocker arm covers.

5. Install intake manifold and carburetor, following the instructions under Intake Manifold.

#### VALVE LIFTER DISASSEMBLY AND ASSEMBLY

Disassembly and assembly procedures for Types I and II valve lifters are different. Each lifter is a matched assembly. If parts of one are intermixed with those of another, improper valve operation may result. Disassemble and assemble each lifter separately. Valve lifters should be tested after assembly as described in Part 21-03. Keep the lifter assemblies in proper sequence so they can be installed in their original bores.

#### DISASSEMBLY—TYPE I

Type I hydraulic valve lifter assembly is shown in Fig. 28.

1. Grasp the lock ring with needle nose pliers to release it from the groove. It may be necessary to depress the plunger to fully release lock ring.

2. Remove the push rod cup, metering valve (disc), plunger and spring.

3. Remove the plunger assembly and the plunger spring. Carefully remove the plunger spring, check valve retainer spring, check valve retainer and check valve disc from the plunger.

#### CLEANING AND INSPECTION

Refer to Part 21-01 for cleaning and inspection procedures.

#### ASSEMBLY-Type I

1. Place the plunger upside down on a clean work bench.

2. Place the check valve (disc or ball check) in position over the oil hole on the bottom of the plunger. Set the check valve spring on top of the check valve (disc or ball check).

3. Position the check valve retainer over the check valve and spring then

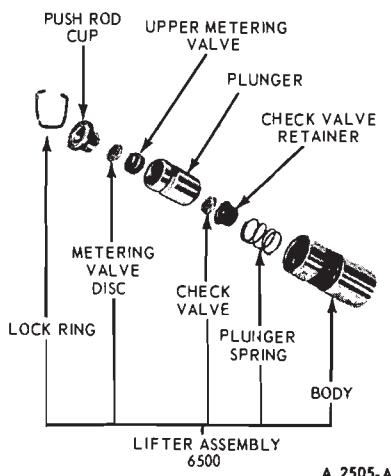


FIG. 29—Type II Hydraulic Valve Lifter Assembly

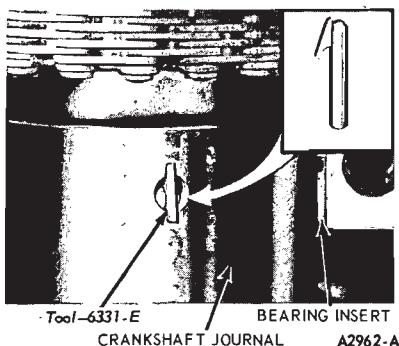


FIG. 30—Removing or Installing Upper Main Bearing Insert

push the retainer down into place on the plunger.

4. Place the plunger spring and the plunger (open end up) into lifter body.

5. Position the metering valve (disc) in the plunger, and place push rod seat in the plunger.

6. Depress the plunger and position the closed end of lock ring in the groove of the lifter body. With the plunger still depressed, position the open ends of lock ring in the groove. Release the plunger, and then depress it again to fully seat the lock ring.

7. Use a hydraulic valve lifter leak-down tester to fill the lifter with test fluid.

#### DISASSEMBLY—TYPE II

Type II hydraulic valve lifter is shown in Fig. 29.

1. Grasp the lock ring with needle nose pliers to release it from the groove. It may be necessary to depress the plunger to fully release lock ring.

2. Remove the push rod cup.

metering valve disc, and the upper metering valve. **Do not bend metering valve or valve tensioning finger.**

3. Remove the plunger assembly and the plunger spring. Carefully remove the plunger spring, check valve retainer and check valve disc from the plunger.

#### CLEANING AND INSPECTION

Refer to Part 21-01 for cleaning and inspection procedures.

#### ASSEMBLY—TYPE II

1. Place the plunger upside down on a clean work surface and center the check valve disc on it. Carefully slide the check valve over disc and down until it bottoms. A slight turning motion will help this. **Use every precaution not to distort it in any way, or to bend preformed fingers.** With a slight turning motion, slide the plunger spring over the metering valve and down until it seats.

2. With the assembly in the upside down position, slide the lifter body down over spring until it slightly compresses the spring.

3. Position the assembly right side up on work surface.

4. Position the upper metering valve in the plunger, taking care not to tilt it to either side, and not to damage or bend the valve tensioning finger. Place the metering valve disc over the metering valve and install the push rod cup. Depress the cup and install the lock ring.

5. Use a hydraulic valve lifter leak-down tester to fill lifter with test fluid.

#### CRANKSHAFT REAR OIL SEAL

Replacement of a crankshaft rear oil seal because of oil leakage requires replacement of upper and lower seals as detailed in Part 21-01.

#### MAIN AND CONNECTING ROD BEARINGS.

Main and connecting rod bearing inserts are selective fits. **Do not file or lap bearing caps or use bearing shims to obtain proper bearing clearance.**

Selective fit bearings are available for service in standard size, 0.001 and 0.002 inch undersize. Undersize bearings, (0.010, 0.020, 0.030 and 0.040 inch) which are not selective fit, are available for use on crankshaft journals that have been refinished.

#### MAIN BEARING REMOVAL

1. Drain the crankcase. Remove the oil level dipstick. Remove the oil pan and related parts, following the procedure under Oil Pan Removal.

2. Remove the oil pump.

3. Replace one bearing at a time, leaving other bearings securely fastened. Remove the main bearing cap to which new bearings are to be installed.

4. Insert the upper bearing removal tool (Tool 6331) in oil hole in crankshaft (Fig. 30).

5. Rotate the crankshaft in the direction of engine rotation to force bearing out of block.

6. Clean the crankshaft journals. Inspect journals and thrust faces (thrust bearing) for nicks, burrs or bearing pick-up that would cause premature bearing wear. When replacing standard bearings with new bearings, it is good practice to fit the bearing to minimum specified clearance. If the desired clearance cannot be obtained with a standard bearing, try one half of a 0.001 or 0.002 inch undersize in combination with a standard bearing to obtain the proper clearance.

#### MAIN BEARING INSTALLATION

1. To install upper main bearing, place plain end of bearing over shaft on locking tang side of block and partially install bearing so tool 6331 can be inserted in oil hole in crankshaft (Fig. 30). With Tool 6331 in oil hole, rotate the crankshaft in the opposite direction of engine rotation until the bearing seats itself. Remove the tool.

2. Fit the main bearings as detailed in Part 21-01 under Fitting Bearings with Plastigage.

3. After the bearing has been fitted, apply light coat of engine oil to journal and bearings. Install the bearing cap. Torque the cap bolts to specifications.

4. Repeat the procedure for remaining bearings that require replacement.

5. If the rear main bearing is to be replaced, remove the rear main bearing cap. Remove and discard the rear oil seal.

6. Clean rear journal oil seal groove and mating surfaces of block and rear main bearing cap.

7. Install the new seal as shown in Fig. 31.

8. Apply thin coating of oil-

resistant sealer to rear main bearing cap at rear of top mating surface. **Do not apply sealer to area forward of oil slinger groove.** Install rear main bearing cap and torque cap bolts to specifications.

9. If thrust bearing cap (No. 3 main bearing) has been removed, install as follows:

Install the thrust bearing cap with bolts finger-tight. Pry the crankshaft forward against the thrust surface of upper half of bearing (Fig. 32). Hold the crankshaft forward and pry thrust bearing cap to rear. This aligns thrust surfaces of both halves of bearing. Retain forward pressure on crankshaft. Torque cap bolts to specifica-

tions.

10. Clean the oil pump inlet tube screen. Prime the oil pump by filling the inlet opening with oil and rotate the pump shaft until oil emerges from the outlet opening. Install the oil pump.

11. Install the oil pan, following procedure under Oil Pan Installation.

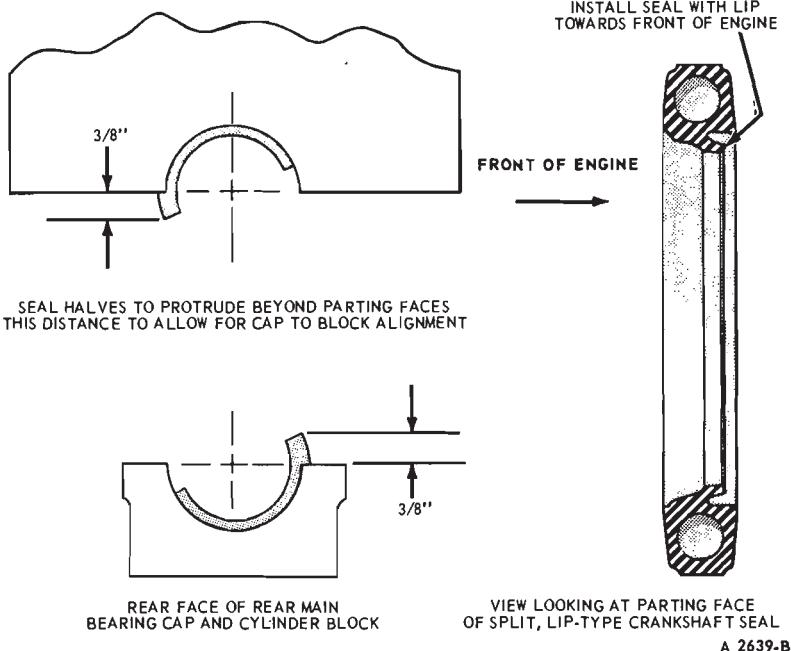
12. Fill the crankcase. Start the engine and check for oil pressure. Operate the engine at fast idle and check for oil leaks.

#### CONNECTING ROD BEARING REMOVAL

1. Follow steps 1 and 2 under

INSTALL SEAL WITH LIP TOWARDS FRONT OF ENGINE

FRONT OF ENGINE



VIEW LOOKING AT PARTING FACE  
OF SPLIT, LIP-TYPE CRANKSHAFT SEAL  
A 2639-B

FIG. 31—Crankshaft Rear Oil Seal Installation

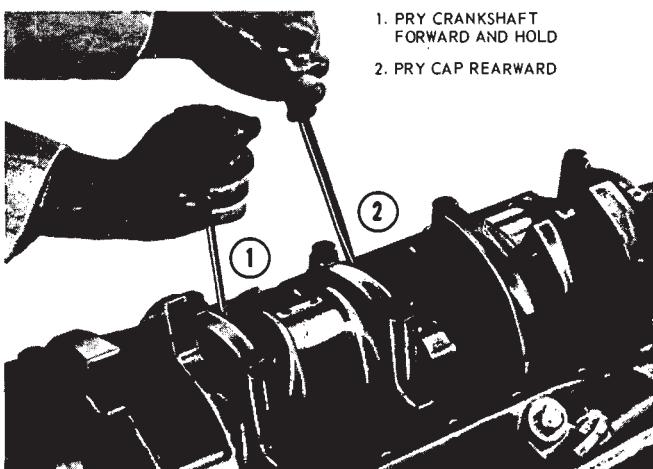
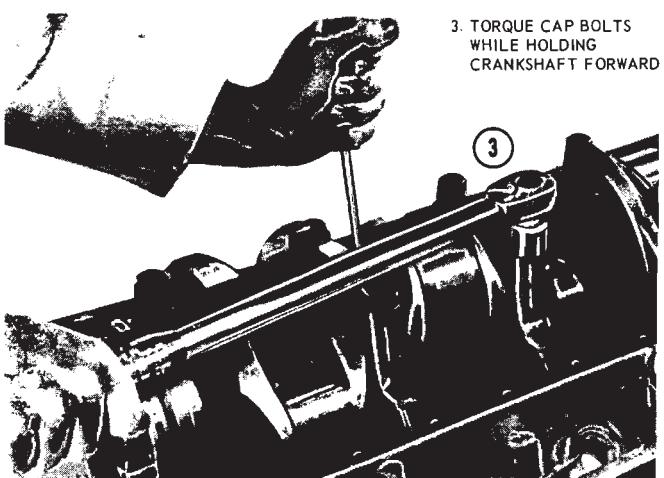


FIG. 32—Aligning Thrust Bearing



#### Main Bearing Removal.

2. Turn the crankshaft until connecting rod to which new bearings are to be fitted is down. Remove the connecting rod cap. Remove the bearing inserts from rod and cap.

3. Be sure the bearing inserts and bearing bore in connecting rod and cap are clean. Foreign material under inserts will distort bearing and cause a failure.

4. Clean the crankshaft journal. When replacing standard bearings with new bearings, it is good practice to fit the bearing to minimum specified clearance.

#### CONNECTING ROD BEARING INSTALLATION

1. Fit connecting rod bearings as detailed in Part 21-01 under Fitting Bearings with Plastigage.

2. Install the bearing inserts in the connecting rod and cap with tangs in the slots provided.

3. Pull the connecting rod assembly down firmly on the crankshaft journal.

4. Apply a light coat of engine oil to the journal and bearings. Install the connecting rod cap. Be sure the connecting rod bolt heads are properly seated in the connecting rod. Torque the nuts to specifications.

5. Repeat the procedure for the remaining connecting rods that require new bearings.

6. To complete installation, follow instructions under Main Bearing Installation.

#### CLEANING AND INSPECTION

Refer to Part 21-01, Section 3 for cleaning and inspection procedures.

## PISTONS AND CONNECTING RODS

### REMOVAL

1. Drain the cooling system and crankcase. Remove the intake manifold, cylinder heads, oil pan and oil pump, following procedures in this section.

2. Remove any ridge and/or deposits from upper end of cylinder bores as follows:

Turn the crankshaft until the piston to be removed is at bottom of its travel. Place a cloth on top of the piston to collect cuttings. Remove any ridge and/or deposits from the upper end of the cylinder bore. Remove the cylinder ridge with a ridge cutter. Follow instructions furnished by tool manufacturer. **Never cut into ring travel area in excess of 1/32 inch when removing ridges.** Repeat the procedure at the remaining cylinders.

3. Make sure that all connecting rod caps are marked so they can be installed in their original positions.

4. Turn the crankshaft until the connecting rod being removed is down.

5. Remove the connecting rod nuts and cap.

6. Push the connecting rod and piston assembly out through the top of the cylinder with the handle end of a hammer. **Avoid damage to the crankshaft journal or cylinder wall when removing the piston and rod.**

7. Remove the bearing inserts from the connecting rod and cap.

8. Install the cap on the connecting rod from which it was removed.

### INSTALLATION

1. If new piston rings are to be installed, remove the cylinder wall glaze. Follow instructions as detailed in Part 21-01.

2. Oil the piston rings, pistons and cylinder walls with light engine oil. **Be sure to install pistons in the same cylinders from which they were removed or to which they were fitted.** Connecting rod and bearing caps are numbered from 1 to 4 in the right bank, and 5 to 8 in the left bank, beginning at the front of engine. Numbers on the connecting rod and bearing cap must be on the same side when installed in the cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and the connecting rod should be numbered to correspond with the new cylinder

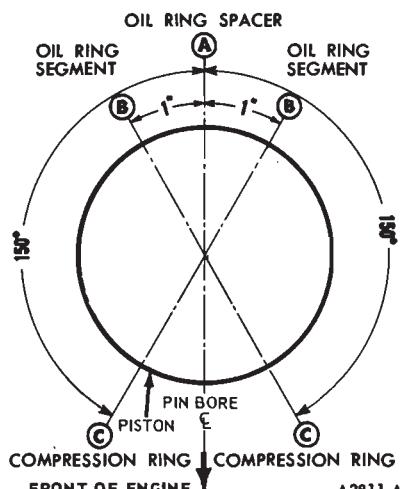


FIG. 33—Piston Ring Spacing

number.

3. Make sure that ring gaps are properly spaced around circumference of piston (Fig. 33).

4. Install piston ring compressor on piston and push in with hammer handle until it is slightly below top of cylinder (Fig. 32). Be sure to guide connecting rods while tapping them into position to avoid damaging crankshaft journals. **Install piston with indentation notch in piston head toward front of engine.**

5. Check clearance of each bearing, following procedure under Fitting Connecting Rod Bearings, Part 21-01.

6. After the bearings have been fitted, apply a light coat of engine oil to the journals and bearings.

7. Turn the crankshaft throw to the bottom of the stroke. Push the piston all the way down until the connecting rod bearing seats on the crankshaft journal.

8. **Install the connecting rod cap. Be sure connecting rod bolt heads are properly seated in the connecting rod. Torque the nuts to specifications.**

9. After the piston and connecting rod assemblies have been installed, check the side clearance between the connecting rods on each crankshaft journal.

10. Disassemble, clean and assemble the oil pump. Clean the oil pump inlet tube screen, and oil pan and the block gasket surfaces.

11. Prime the oil pump by filling the inlet port or outlet port with engine oil and rotating the pump shaft to distribute oil within the housing. Install the oil pump. Install the oil pan, following the procedure under Oil Pan Installation.

12. Install the cylinder heads, following instructions under Cylinder Head Installation.



FIG. 34—Installing Piston Assembly

13. Install the intake manifold, following instructions under Intake Manifold Installation.

14. Fill and bleed the cooling system. Fill the crankcase to the correct level with the specified engine oil.

15. Start the engine and adjust the ignition timing. Connect the distributor vacuum line.

16. Operate the engine at fast idle and check for oil and coolant leaks. With the engine temperatures stabilized, adjust the engine curb idle speed and mixture.

17. Install the air cleaner and intake duct assembly.

### DISASSEMBLY

1. Remove the bearing inserts from the connecting rod and cap.

2. Mark the pistons and pins to assure assembly with same rod and installation in the same cylinders from which they were removed.

3. Using an Arbor Press and tool shown in Fig. 35, press the piston pin from the piston and connecting rod. Remove the piston rings.

### CLEANING AND INSPECTION

Refer to Part 21-01, for cleaning and inspection procedures.

### REPAIRS

Refer to Part 21-01, for repair procedures.

### ASSEMBLY

**Check the fit of a new piston in the cylinder bore before assembling piston and piston pin to connecting rod.**

Piston pin bore of connecting rod and diameter of piston pin must be within specifications.

1. Apply a light coat of engine oil to all parts. Assemble the piston to

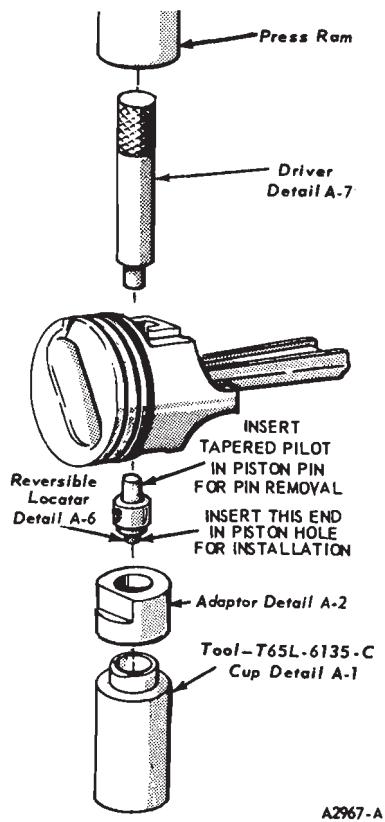


FIG. 35—Removing or Installing Piston Pin

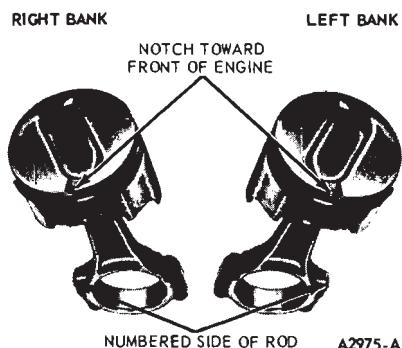


FIG. 36—Correct Piston and Rod Positions

the connecting rod with the cylinder number side of the connecting rod and indentation notch in piston positioned as shown in Fig. 36.

2. Start the piston pin in the piston and the connecting rod. Using an Arbor Press, press the piston pin through the piston and connecting rod until the end of pin is  $1/16$ -inch to  $1/8$ -inch below chamfer of the pin bore in the piston.

3. Check the end gap of all piston rings. End gap must be within specifications. Follow the instructions contained on piston ring package and install the piston rings.

4. Check the ring side clearance of

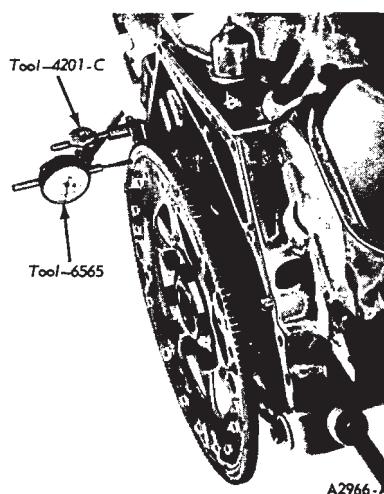


FIG. 37—Checking Flywheel Runout

compression rings with a feeler gauge inserted between the ring and the lower land. Feeler gauge should slide freely around the ring circumference without binding. Any wear will form a step at the inner portion of the lower land. If the lower lands have high steps, replace the piston.

5. Be sure the bearing inserts and bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause failure. Install bearing inserts in connecting rod and cap with tangs fitting in slots provided.

## FLYWHEEL

### REMOVAL

1. Remove the transmission from vehicle.

2. Index the flywheel reinforcing plate to flywheel for installation purposes (automatic transmission). Remove the mounting bolts, reinforcing plate (if so equipped) and flywheel from the crankshaft.

### INSPECTION

Refer to Part 21-01, for inspection procedure.

### INSTALLATION

1. Install the reinforcing plate (automatic transmission) on flywheel and align index marks. Install reinforcing plate (automatic transmission) and flywheel on crankshaft as a unit. Install the mounting bolts and torque to specifications.

2. Check flywheel runout (Fig. 37) and ring gear runout following proce-



FIG. 38—Oil Filter

dure in Part 21-01.

3. Install transmission assembly in vehicle.

## OIL FILTER

### REMOVAL

The oil filter assembly is shown in Fig. 38.

1. Place a drip pan under the filter. Unscrew the filter from the adapter fitting and clean the adapter recess.

### INSTALLATION

1. Coat the gasket on a new filter with oil. Place a new filter on the adapter fitting. Hand tighten the filter until the gasket contacts the sealing surface then tighten  $1/2$  turn more.

2. Operate the engine at fast idle and check for oil leaks. If oil leaks are evident, perform the necessary repairs to correct the leakage. Check the oil level and fill the crankcase to the correct level.

## OIL PAN

### CONTINENTAL MARK III

#### Removal

1. Disconnect the battery ground cable. Disconnect the two transmission oil cooler lines from the radiator.

2. Remove the radiator shroud attaching bolts and position the shroud over the fan.

3. Raise the vehicle on a hoist.

4. Drain the crankcase, then remove the oil filter.

5. Remove end attachments of front stabilizer bar and rotate ends of bar down to raise center of bar.

6. Support the engine with a jack, then remove the bolt that attaches each engine support to insulator.

7. Remove the bolt that attaches the transmission oil cooler line retaining bracket to the cylinder block.

8. Remove the two starter motor attaching bolts.

9. Raise the engine high enough to remove the engine support insulator attaching bolts, then remove the right

insulator and heat shield. Position a wood block 3 inches high between each engine support bracket and exhaust manifold. Lower the engine to allow the blocks to support the engine.

**10.** Remove the converter housing to cylinder block support attaching bolts and remove the brackets.

**11.** Remove the oil pan attaching bolts and lower the pan to the No. 2 crossmember.

**12.** Move the transmission oil cooler lines upward, then remove the pan.

**13.** Clean all gasket and seal material from the cylinder block and oil pan.

### Installation

**1.** Position the oil pan gaskets and seals on the cylinder block.

**2.** Hold the oil pan in position and install the attaching bolts. Torque the bolts to specification.

**3.** Install the converter housing to cylinder block supports and torque the attaching bolts to specification.

**4.** Tighten the starting motor attaching bolts to specification.

**5.** Raise the engine and remove the two wood support blocks.

**6.** Install the engine support insulator and heat shield on the right side of the engine and torque the attaching bolts to specification.

**7.** Lower the engine into place and install and torque the engine support bolts to specification.

**8.** Rotate front stabilizer bar into position and attach ends to lower control arms.

**9.** Clean the oil filter mating surface and install the filter.

**10.** Secure the transmission oil cooler line retaining bracket to the cylinder block with the attaching bolt.

**11.** Lower the vehicle to the floor.

**12.** Position the radiator shroud and install the attaching bolts.

**13.** Connect the transmission oil cooler lines to the radiator.

**14.** Fill the crankcase to the proper level with the recommended oil.

**15.** Fill the power steering reservoir to the correct level with the specified lubricant.

**16.** Connect the battery ground cable. Start the engine and check for leaks and correct as required.

### LINCOLN CONTINENTAL

#### Removal

**1.** Disconnect the battery ground

cable. Disconnect the radiator shroud from the radiator.

**2.** Raise the vehicle on a hoist and drain the crankcase.

**3.** Remove the starter attaching bolts.

**4.** Place a floor jack under front of oil pan, with a block of wood between jack and pan. Raise the jack just high enough to remove weight of engine from the front supports. Remove the through bolt from each support. Remove the two forward bolts from the right engine support insulator. Loosen the rear bolt, then pivot the insulator upward to gain access to the converter support bracket attaching bolts.

**5.** Remove the converter support bracket attaching bolts and remove the bracket from each side of the oil pan. Install a one inch wood block under each engine support bracket, then remove the jack.

**6.** Remove the end attachments of the front stabilizer bar and rotate ends of bar down to raise the center of bar. Remove the oil filter.

**7.** Remove the oil pan attaching bolts, then remove the oil pan.

#### Cleaning and Inspection

Refer to Part 21-01, Section 3 for cleaning and inspection procedures. Check the gasket surface for damage caused by over-torqued bolts. Straighten the surface as required to restore original flatness.

#### Installation

**1.** Clean the gasket surfaces of the block and oil pan. Coat the block surface and oil gasket surface with oil-resistant sealer. Position the oil pan gaskets on the cylinder block.

**2.** Position the oil pan front seal on the cylinder front cover. Be sure that the tabs on the seal are over the oil pan gasket.

**3.** Position the oil pan rear seal on the rear main bearing cap. Be sure that the tabs on the seal are over the oil pan gasket.

**4.** Hold the oil pan in place against the block and install a bolt, finger-tight, on each side of the pan. Install the remaining bolts. Torque the bolts from the center outward in each direction to specifications.

**5.** Clean the oil filter seal surface and install the oil filter.

**6.** Rotate the front stabilizer bar into position and attach the ends to lower control arms.

**7.** Install the cylinder block to

converter housing supports. Install and tighten the starter attaching bolts.

**8.** Raise the engine slightly with a floor jack and wood block against forward edge of oil pan. Remove the wood blocks from under the front support insulators. Install the two insulator attaching bolts on the right insulator. Tighten the three bolts to specification. Lower the engine as required to install the through bolts. Torque the nuts and bolts to specifications.

**9.** Lower the vehicle on a hoist and attach shroud to radiator. Connect the battery ground cable.

**10.** Fill crankcase to proper level with the specified oil. Start the engine and check for leaks.

### FORD, MERCURY AND THUNDERBIRD

#### Removal

**1.** Disconnect the battery ground cable. Disconnect the radiator shroud from the radiator, and position it over the fan.

**2.** Raise the vehicle on a hoist and drain the crankcase.

**3.** Remove the bolt that attaches the vacuum line retainer clip to the upper right side of the converter housing. Remove the through bolt from each engine support. Place floor jack under the front edge of the oil pan, with block of wood between jack and oil pan. Raise the engine just enough to insert 1 1/4 inch blocks of wood between the insulators and brackets. Remove the floor jack.

**4.** Disconnect the starter cable, remove attaching bolts, and position the starter on the steering linkage.

**5.** Remove the end attachments of the front stabilizer bar and rotate the ends of the bar down to raise center of the bar.

**6.** Remove the oil pan attaching bolts and remove the pan. It may be necessary to rotate the crankshaft to provide clearance between the pan and crankshaft throws or counterweights.

#### Cleaning and Inspection

Refer to Part 23-01, Section 3 for cleaning and inspection procedures. Check the gasket surface for damage caused by over-torqued bolts. Straighten the surface as required to restore original flatness.



**FIG. 39—Removing Oil Pump Relief Valve Plug**

#### Installation

1. Clean the gasket surfaces of the block and oil pan. Coat the block surface and the oil pan gasket surface with oil-resistant sealer. Position the oil pan gaskets on the cylinder block.
2. Position the oil pan front seal on the cylinder front cover. Be sure that the tabs on the seal are over the oil pan gasket.
3. Position the oil pan rear seal on the rear main bearing cap. Be sure that the tabs on the seal are over the oil pan gasket.
4. Hold the oil pan in place against the block and install a bolt, finger-tight, on each side of the oil pan. Install the remaining bolts. Torque the bolts from the center outward in each direction to specifications.
5. Rotate the front stabilizer bar into position and attach the ends to the lower control arms.
6. Install the starter and connect the starter cable.
7. Raise the engine slightly with a floor jack and wood block against the forward edge of the oil pan. Remove the wood spacers from under the

front support insulators. Lower the engine as required to install the insulator through bolts. Remove the jack, then torque the nuts to specifications.

8. Lower the vehicle on a hoist and attach shroud to radiator. Connect the battery ground cable.

9. Fill the crankcase. Start the engine and check for leaks.

#### OIL PUMP

##### REMOVAL

1. Remove the oil pan, following the procedure under Oil Pan Removal.

2. Remove the oil pump mounting bolts, and remove the pump from the cylinder block.

##### INSTALLATION

1. Prime the oil pump by filling the inlet or outlet port with engine oil. Rotate the pump shaft to distribute oil within the pump body.

2. Install the distributor intermediate shaft in the oil pump rotor shaft. Apply oil-resistant sealer to the new oil pump mounting gasket and install the gasket on the oil pump.

3. Insert the intermediate shaft into the distributor shaft hex bore. Make certain that the intermediate shaft is properly seated. Do not force the pump into position if it will not seat readily. Intermediate shaft hex may be misaligned with distributor shaft. To align, rotate the intermediate shaft until it can be seated. Secure the oil pump to cylinder block and torque the screws to specifications. Make certain that gasket is properly installed. Oil leakage can cause loss of oil pressure and extensive engine

damage.

4. Install the oil pan and related parts, following procedure under Oil Pan Installation.

#### DISASSEMBLY

1. Remove the four screws and washers securing the oil pump cover to the oil pump.

2. Remove the oil pump outer rotor and rotor shaft assembly from the oil pump housing.

3. Scrape the stake marks which secure the relief valve plug in the oil pump housing. To remove the plug, insert a self-tapping screw in the relief valve plug. Use pliers to remove plug from oil pump housing (Fig. 39). Use care to prevent the loss of the relief valve spring.

4. Remove the spring and relief valve from the oil pump housing.

#### CLEANING AND INSPECTION

Refer to Part 21-01, Section 3 for cleaning and inspection procedures.

#### ASSEMBLY

1. Install the relief valve, spring and the relief valve plug in the oil pump housing. Press the plug inward until it seats; then, stake in place. The relief hole in the plug must not be covered or obstructed.

2. Install the outer rotor and rotor shaft in the housing. Be sure that the identification mark on the outer rotor is on the same side as the identification mark on the inner rotor. These parts are matched sets and should only be replaced as an assembly. Fill the housing with engine oil for priming purposes.

## 3 ENGINE REMOVAL AND INSTALLATION

The engine removal and installation procedures are for the engine only without the transmission attached.

#### REMOVAL

1. Raise the hood and mask the edges of the hood, fenders and cowl to protect the paint. Place fender covers on fenders.
2. Remove the hood.
3. Drain the cooling system at the

radiator and the cylinder block.

4. Disconnect the ground cable from the battery. Remove the air cleaner and intake duct assembly. Cover the carburetor air horn with a clean cloth.

5. Disconnect the radiator upper and lower hoses at the engine. Disconnect the transmission oil cooler lines at the radiator if equipped with an automatic transmission.

6. Remove the cooling fan-to-water

pump hub attaching bolts. Remove the cooling fan and the shroud.

7. Remove the radiator upper support and the radiator.

8. If equipped with air conditioning, isolate the compressor and disconnect the service valves and hoses at the compressor. Remove the clamp bolt at the air conditioner muffler support if so equipped and position the refrigerant lines out of the way.

Loosen the compressor drive belt

idler pulley and remove the drive belt. Remove the compressor support bracket-to-water pump bolt. Remove the compressor-to-mounting bracket bolts. Remove the power steering pump and position it to one side. Disconnect the compressor clutch wire and remove the compressor. Remove the compressor mounting bracket and idler pulley.

9. Disconnect the fuel inlet line at the fuel pump. Plug or cap the line to prevent fuel loss.

10. Loosen the alternator adjusting arm and mounting bolts. Remove the drive belts and water pump pulley. Remove the alternator and mounting brackets and position out of way, leaving the wires connected.

11. Disconnect the ground cable at the right front corner of cylinder block. Disconnect the heater hoses. Remove the transmission fluid filler tube attaching bolt from the right valve rocker arm cover, and position the transmission filler tube out of the way.

12. Disconnect all vacuum lines at the rear of intake manifold.

13. Disconnect the speed control cable at carburetor and bracket, if so equipped. Disconnect the accelerator rod and transmission rod at the bell crank, and secure out of way.

14. Disconnect the engine wiring harness at the multi-connector on dash.

15. Raise the vehicle on a hoist. Disconnect the inlet pipes at exhaust manifolds. Disconnect the idler arm bracket from underbody, and pull idler arm assembly down.

16. Disconnect the starter cable from starter solenoid or starter. Remove starter attaching bolts and remove starter by moving starter assembly forward, rotating it to turn solenoid outward, then removing it toward rear of vehicle (460 CID only). On the 429 CID, lift it from the engine.

17. On Lincoln Continental and Mark III models, remove the cylinder block to converter housing supports. Remove access cover from converter housing. Remove the flywheel to converter attaching nuts, rotating the flywheel as necessary. Remove the converter-to-engine lower rear cover plate attaching bolts.

On manual transmission equipped vehicles, remove the transmission-to-flywheel housing attaching bolts. Disconnect the clutch linkage.

18. Remove the nuts attaching the front support insulators to the underbody crossmember.

19. Hold the transmission in position with a support tool.

20. Lower the vehicle on hoist. Remove converter upper housing to cylinder block attaching bolts (left side). Disconnect the coil wire, and remove the coil and bracket assembly from the intake manifold.

21. Attach an engine lifting sling, Tool No. T53L-300-A, and hoist to lifting brackets at exhaust manifolds. Carefully remove engine from the vehicle. Install the engine on a work stand and remove the lifting sling.

## INSTALLATION

1. Attach engine lifting sling, Tool No. T53L-300-A, and hoist to lifting brackets at exhaust manifolds. Remove engine from work stand.

2. Position new manifold gaskets on the inlet pipes. Carefully lower engine into vehicle. With engine supported by lifting sling, align converter-to-flywheel mounting studs with flywheel. If working on a Ford or Mercury with a manual transmission, align the clutch splines with the transmission input shaft. Position the engine support insulator heat shields, then lower the engine, guiding the front support insulator studs into holes in underbody crossmember.

3. Install the converter upper housing-to-cylinder block or transmission-to-flywheel housing attaching bolts and torque to specifications. Remove the transmission support. Position the hoist out of the way and remove lifting sling.

4. Raise the vehicle on a hoist and install the front support insulator stud nuts. Torque them to specifications. Install the converter housing-to-engine rear cover plate or transmission-to-flywheel housing attaching bolts and torque them to specifications.

5. Install the nuts and lock washers on converter-to-flywheel mounting studs and torque nuts to specifications, if equipped with automatic transmission. Install converter access plate. If working on a Lincoln Continental or Mark III, install cylinder block to converter housing supports.

6. Install the starter and connect starter cable.

7. Attach idler arm bracket to underbody and torque attaching nuts and bolts to specifications.

8. With gaskets in place on inlet pipes, guide pipe ends into intake manifold flanges. Install nuts on flange studs and torque to specifications.

9. Lower the vehicle on a hoist and

connect accelerator and transmission rods to bell crank. Connect engine wiring harness at multi-connector at dash.

10. Connect all vacuum lines at rear of intake manifold. Connect speed control cable; if so equipped, to carburetor linkage and bracket.

11. Connect heater hoses. Set transmission filler tube in position and tighten bolt at right valve rocker arm cover to secure tube.

12. Connect ground wire to right front corner of cylinder block. Install alternator and mounting brackets.

13. If equipped with air conditioning, install the compressor upper mounting bracket to left cylinder head. Position the air conditioner muffler bracket and power steering reservoir or pump on studs in left cylinder head. Install compressor to upper mounting bracket and attach compressor support bracket to water pump. Connect compressor clutch wire bullet connector.

14. Connect the fuel inlet line to the fuel pump. Install the coil to intake manifold and connect wires.

15. If equipped with air conditioning, connect the service valves to compressor and install air conditioner muffler.

16. Set radiator in position and install the radiator upper support. Install the radiator upper and lower hoses. Connect the oil cooler lines to radiator if vehicle is equipped with automatic transmission.

17. Fit the water pump pulley in position. Install all drive belts.

18. Place fan assembly inside radiator shroud and install shroud. Install fan assembly to water pump hub and torque bolts to specifications.

19. Fill the crankcase, cooling system and power steering reservoir to the correct level and specified lubricants. Adjust the tension of drive belts to specifications.

20. Connect the distributor and vacuum lines. Install the air cleaner and intake duct, crankcase ventilation system air supply hose and oil filler cap.

21. Connect the battery. Start the engine and check for leaks.

22. When engine temperature stabilizes, adjust the ignition timing, distributor advance, engine idle speed and mixture, and transmission linkage, as required.

23. If equipped with air conditioning, check the system and charge as necessary.

24. Install the hood. Remove the masking tape and fender covers.

## 4 MAJOR REPAIR OPERATIONS

When installing nuts or bolts that must be torqued, refer to Section 5. Oil the threads with light engine oil. **Do not oil threads that require oil-resistant or water-resistant sealer.**

To perform following operations, it is necessary to remove the engine and install it on a work stand.

### CRANKSHAFT

Crankshaft and related parts are shown in Fig. 40.

#### REMOVAL

1. Disconnect the wires from the spark plugs. Remove the spark plugs to allow easy rotation of crankshaft.

2. Remove the fuel pump and the oil filter. Slide water pump bypass hose clamp toward the water pump.

3. Remove the cap screw and washer from the end of the crankshaft. Install a puller on the crankshaft vibration damper (Fig. 20) and remove damper. Remove Woodruff key.

4. Remove the cylinder front cover

and water pump as an assembly. Check the timing chain deflection. Remove the timing chain and sprockets as detailed in Section 2, Cylinder Front Cover and Timing Chain Removal.

5. Invert the engine on a work stand. Remove the flywheel and the engine rear cover plate. Remove the oil pan and gasket. Remove the oil pump.

6. Make sure that all bearing caps (main and connecting rod) are marked so they can be installed in their original locations. Turn the crankshaft until the connecting rod from which cap is being removed is down, then remove the bearing cap. Push the connecting rod and piston assembly up into the cylinder. Repeat this procedure until all connecting rod bearing caps are removed.

7. Remove the main bearing caps.

8. Carefully lift the crankshaft out of the block so thrust bearing surfaces are not damaged. Handle the crankshaft with care to avoid possible fracture or damage to finished surfaces.

### CLEANING AND INSPECTION

Refer to Part 21-01, Section 3 for cleaning and inspection procedures. Clean the crankshaft damper.

### REPAIRS

To refinish journals, dress minor imperfections, etc., refer to Part 21-01.

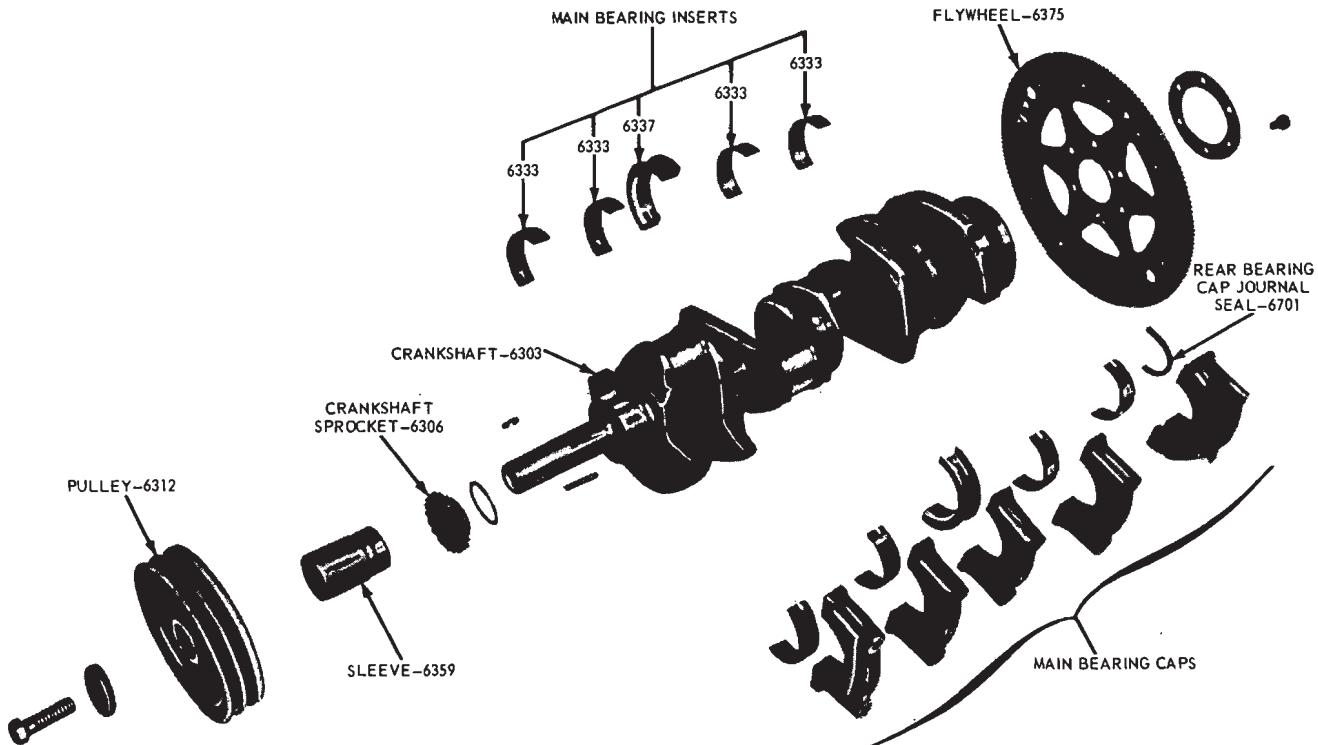
### INSTALLATION

1. Remove the rear journal oil seal from block and rear main bearing cap.

2. Remove the main bearing inserts from the block and bearing caps.

3. Remove the connecting rod bearing inserts from the connecting rods and caps.

4. If the crankshaft main bearing journals have been refinished to a definite undersize, install the correct undersize bearing. Be sure that bearing inserts and bearing bores are clean. Foreign material under inserts will distort the bearing and cause failure.



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FIG. 40—Crankshaft and Related Parts

5. Place the upper main bearing inserts in the bores with tang in slot.

6. Install lower main bearing inserts in bearing caps.

7. Clean the rear journal oil seal groove and mating surfaces of the block and rear main bearing cap.

8. Install a new rear main bearing oil seal in the block and cap as detailed in Part 21-01.

9. Carefully lower the crankshaft into place. Be careful not to damage bearing surfaces.

10. Check the clearance of each main bearing as detailed in Part 21-01.

11. After bearings have been fitted, apply light coat of engine oil to journals and bearings. Install a new seal in the rear main bearing cap and install the rear main bearing cap. Install all bearing caps except thrust bearing cap (No. 3 bearing). Be sure that main bearing caps are installed in original locations. Torque the bearing cap bolts to specifications.

12. Install the thrust bearing cap with bolts fingertight.

13. Pry the crankshaft forward against thrust surface of upper half of bearing (Fig. 32).

14. Hold crankshaft forward and pry thrust bearing cap to rear (Fig. 32). This aligns thrust surfaces of both halves of bearing.

15. Retain forward pressure on the crankshaft. Tighten cap bolts to specifications.

16. Force the crankshaft toward the rear of engine.

17. Check the crankshaft end play (refer to Part 21-01).

18. Install new bearing inserts in the connecting rods and caps. Check clearance of each bearing, following procedure detailed in Part 21-01, Fitting Bearings with Plastigage.

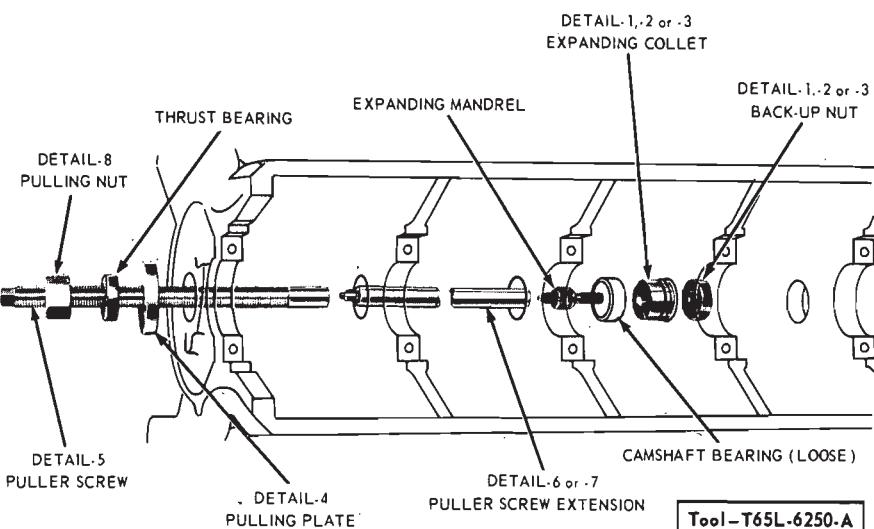
19. After the connecting rod bearings have been fitted, apply light coat of engine oil to journals and bearings.

20. Turn the crankshaft throw to bottom of its stroke. Push the piston all the way down until rod bearing seats on the crankshaft journal.

21. Install the connecting rod cap. Be sure that connecting rod bolt heads are properly seated in connecting rod. Torque nuts to specifications.

22. After piston and connecting rod assemblies have been installed, check side clearance between connecting rods on each connecting rod crankshaft journal.

23. Install timing chain and sprockets, cylinder front cover, and crankshaft damper as detailed in Section 2, Cylinder Front Cover and



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FIG. 41—Replacing Camshaft Bearing

#### Timing Chain Installation.

24. Install the engine rear cover plate. Coat flywheel attaching bolt threads with oil-resistant sealer. Position flywheel and reinforcing plate (reinforcing plate on automatic transmission only) on crankshaft flange. Install and torque the bolts to specifications.

25. Clean the oil pan, oil pump and oil pump screen. Prime the oil pump by filling inlet or outlet port with engine oil and rotating pump shaft to distribute oil within housing. Install oil pump and oil pan by following procedures under Oil Pan and Oil Pump Installation.

26. Install the oil filter and fuel pump, and connect the fuel lines.

27. Install the spark plugs and connect the spark plug wires.

28. Install the engines in vehicle.

#### CAMSHAFT BEARINGS

Camshaft bearings are available pre-finished to size for standard and undersize journal diameters.

#### REMOVAL

1. Remove the camshaft, flywheel, and crankshaft, following the appropriate procedures in this part. Push pistons to top of cylinders.

2. Remove the camshaft rear bearing bore plug as detailed in Part 21-01, Section 2. Remove camshaft bearings (Fig. 41).

#### INSTALLATION

1. Select the proper size expanding collet and back-up nut and assemble on expanding mandrel. With the expanding collet collapsed, install the collet in the camshaft bearing, and tighten back-up nut on expanding mandrel until collet fits camshaft bearing.

2. Assemble the puller screw and extension (if necessary) as shown in Fig. 41 and install on expanding mandrel. Wrap a cloth around threads of the puller screw to protect the front bearing or journal. Tighten pulling nut against the thrust bearing and pulling plate to remove camshaft bearing. Hold a wrench on the end of puller screw to prevent it from turning.

3. Repeat the procedure for each bearing. To remove the front bearing, install puller screw from rear of cylinder block.

4. Position new bearings at bearing bores, and press in place with the tool shown in Fig. 41. Be sure to center the pulling plate and puller screw to avoid bearing damage. Failure to use correct expanding collet can cause severe bearing damage. Align oil holes in bearings with oil holes in cylinder block before pressing them into block. Be sure front bearing is installed specified distance below front face of cylinder block (Fig. 42).

5. Install the core plug as detailed



FIG. 42—Measuring Depth of Camshaft Front Bearing

in Part 21-01, Section 2.

6. Install the camshaft, crankshaft, flywheel and related parts, following appropriate procedures in this part, except do not check connecting rod and main bearing clearances.

## CYLINDER ASSEMBLY

### DISASSEMBLY

Follow the procedure under Engine Disassembly. Remove the cylinder head dowels from the cylinder block. Remove the cylinder block drain plugs, and remove the cylinder assembly from work stand.

### CLEANING

Clean gasket and seal surfaces of all parts and assemblies (refer to Part 21-01, Section 3).

### ASSEMBLY

Install the replacement cylinder block assembly on a work stand. Install the cylinder block drain plugs and cylinder head dowels. Transfer all parts removed from old cylinder assembly to new cylinder assembly, following procedures under Engine Assembly. Check all assembly clearances and correct as necessary.

## CYLINDER BLOCK

### DISASSEMBLY

Follow procedure under Engine Disassembly. Remove cylinder head dowels and drain plugs from the cylinder block. Remove the cylinder block from work stand.

### CLEANING AND INSPECTION

Clean the crankshaft damper and gasket and seal surfaces of all parts

and assemblies (refer to Part 21-01, Section 3).

### ASSEMBLY

Install the replacement cylinder block on a work stand. Install the cylinder block drain plugs and cylinder head dowels. Transfer parts removed from old cylinder block to new cylinder block by following procedure under through 32 and 34 through 57 under Engine Assembly. Check all assembly clearances and correct as necessary.

## ENGINE DISASSEMBLY

1. Install the engine on work stand.
2. Remove the distributor cap and spark plug wires as an assembly.
3. Disconnect distributor vacuum line at the distributor. Remove carburetor fuel inlet line and fuel pump outlet line. Remove the oil filter and adapter.
4. Slide the clamp on water pump bypass hose toward water pump.
5. Remove the valve rocker arm covers and crankcase ventilation system.
6. Remove the ignition coil. Remove the distributor hold-down bolt and remove distributor.
7. Remove the intake manifold attaching bolts. Raise the manifold and carefully remove from engine. Discard gaskets and seals.
8. Loosen valve rocker arm stud nuts so valve rocker arms can be rotated. Remove the valve push rods in sequence and put them in a rack or holder so they can be installed in original positions.
9. Using a magnet, remove the valve lifters and place them in a rack so they can be installed in original bores.
- If the valve lifters are stuck, use plier-type tool (T52T-6500-DJD or 6500-D) to remove them. Rotate the lifter back and forth to loosen it from gum or varnish.
- Internal parts of each hydraulic valve lifter are matched sets. Do not intermix parts. Keep assemblies intact until they are to be cleaned.
10. Remove the exhaust manifolds and spark plugs.
11. Remove the cylinder head bolts and lift cylinder heads off block. Discard cylinder head gaskets.
12. Remove the cap screw and washer from end of crankshaft. Install puller on crankshaft vibration damper (Fig. 20) and remove the vibration damper and Woodruff key.
13. Remove the cylinder front cover attaching screws. Remove the cylinder front cover and water pump as an assembly. Discard gasket.
14. Check the timing chain deflection and remove timing chain and sprockets as detailed in Section 2 under Cylinder Front Cover and Timing Chain Removal. Remove the crankshaft sprocket key.
15. Remove any ridge and/or carbon deposits from the upper end of cylinder bores. Move the piston to bottom of its travel and place a cloth on top of piston to collect cuttings. Remove the cylinder ridge with ridge cutter. Follow the instructions furnished by the tool manufacturer. Never cut into the ring travel area in excess of 1/32 inch when removing ridges. After the ridge has been removed, remove the cutter from cylinder bore.
16. Remove the flywheel.
17. Remove the rear cover plate.
18. Invert the engine. Remove the oil pan and discard gaskets and seals.
19. Remove the oil pump. Remove the intermediate drive shaft. Discard the oil pump gasket.
20. Make sure that all connecting rods and caps are marked so they can be installed in original locations. Turn the crankshaft until the connecting rod being removed is down. Remove the rod cap.
21. Push the connecting rod and piston assembly out top of the cylinder with a handle end of a hammer. Avoid damage to connecting rod journal or cylinder wall when removing the piston and rod.
22. Remove the bearing inserts from the connecting rods and caps. Install the rod caps on connecting rods from which they were removed.
23. Remove the main bearing caps.
24. Carefully lift the crankshaft out of the cylinder block so that thrust bearing surfaces are not damaged. Handle crankshaft with care to avoid possible fracture or damage to finished surfaces.
25. Remove the rear journal oil seal from block and rear bearing cap.
26. Remove the main bearing inserts from block and bearing caps. Install the main bearing caps in original positions.
27. Remove the camshaft thrust plate. Carefully remove the camshaft by pulling toward front of engine. Use caution to avoid damaging journals and lobes.
28. Remove the camshaft rear bearing bore plug as detailed in Part

21-01, Section 2. Remove the cam-shaft bearings (Fig. 41).

## ENGINE ASSEMBLY

If the cylinder block is to be replaced, transfer the cylinder head dowels and cylinder block drain plugs to a new cylinder block and follow procedures.

1. If the original block is used, remove the glaze from cylinder bores by following instructions detailed in Part 21-01, Section 2.

2. Invert the block on a work stand.

3. Position the new camshaft bearings at bearing bores, and press them in place with tool shown in Fig. 41. Align oil holes in bearings and cylinder block before pressing bearings into place. Be sure camshaft front bearing is installed specified distance below front face of cylinder block (Fig. 42).

4. Install the core plug as detailed in Part 21-01, Section 2.

5. Oil the camshaft journals and apply Lubriplate to all lobes, then carefully slide the camshaft through bearings. Install the camshaft thrust plate and check the camshaft end play.

6. Clean the rear journal oil seal groove and mating surfaces of block and rear main bearing cap. Install a new seal in the block as detailed in Part 21-01.

7. If the crankshaft main bearing journals have been refinished to a definite undersize, install the correct undersize bearings. Be sure that bearing inserts and bearing bores are clean. Foreign material under the inserts will distort bearing and cause failure.

Place the upper main bearing inserts in bore with tang in slot.

8. Install the lower main bearing inserts in the bearing cap.

9. Carefully lower the crankshaft into place. **Be careful not to damage bearing surfaces.**

10. Check the clearance of each main bearing, following the procedure under Main Bearing Replacement.

11. After the bearings have been fitted, apply light coat of engine oil to journals and bearings.

12. Install new journal oil seal in cap as detailed in Part 21-01. Apply a thin coating of oil-resistant sealer to rear main bearing cap at rear of top mating surface. **Do not apply sealer to area forward of oil slinger groove.** Install the rear main bearing cap and all other caps except thrust bearing cap (No. 3 bearing). **Be sure that**

**main bearing caps are installed in their original positions.** Torque the bearing cap bolts to specifications.

13. Install the thrust bearing cap and check crankshaft end play.

14. Turn the engine on the work stand so front end is up.

15. Install the pistons and connecting rods by following steps 1 through 9 under Piston and Connecting Rod Installation.

16. Position the sprockets and timing chain on camshaft and crankshaft. Be sure that timing marks on the sprockets are positioned as shown in Fig. 22.

17. Lubricate the timing chain and sprockets with engine oil.

18. Install the fuel pump eccentric, washer and camshaft sprocket cam screw. Torque the sprocket cap screw to specifications.

19. Clean the cylinder front cover and cylinder block gasket surfaces. Install new front oil seal (Fig. 21).

20. Coat block and cover threads with oil-resistant sealer. Position new gasket on block.

21. Install the alignment pilot tool in the cylinder front cover. Position the cover (and water pump) and pilot over the end of the crankshaft and against the block (Fig. 25).

22. Install the cylinder front cover bolts fingertight. While pushing in on the pilot, torque cover bolts to specifications. Remove the pilot. Install the fuel pump with new gaskets.

23. Lubricate the crankshaft with white lead and oil mixture and apply Lubriplate to oil seal rubbing surface of the vibration damper inner hub to prevent damage to oil seal.

24. Install the Woodruff key in the crankshaft. Line up the crankshaft vibration damper keyway with the key in the crankshaft, then install the vibration damper (Fig. 26). Install the damper cap screw and washer, and torque the screw to specifications.

25. Invert the engine on work stand. Position the oil pump intermediate drive shaft into the distributor socket. With the shaft firmly seated in the distributor socket, stop on shaft should touch roof of the crankcase. Remove the shaft and position the stop as necessary.

26. With the stop properly positioned, insert the intermediate drive shaft into the oil pump.

27. Prime the oil pump by filling the inlet or outlet port with engine oil. Rotate the pump shaft to distribute oil within the pump body.

28. Position a new gasket on the pump housing and install the pump

and shaft as an assembly. **Do not attempt to force the pump into position if it will not seat readily.** Drive shaft hex may be misaligned with the distributor shaft. Rotate the intermediate shaft to align. Torque the oil pump attaching screws to specifications.

29. Clean the gasket surfaces of block and oil pan. Coat the block surface and oil pan gasket surface with oil-resistant sealer. Position new gaskets on the block and position new seals on cylinder front cover and rear main bearing cap. Make sure that tabs on seals are over the oil pan gaskets. Install the attaching bolts and torque from center outward to specifications.

30. Turn the engine to normal operating position.

31. Clean the cylinder head and block gasket surfaces. Install the head gasket over the cylinder head dowels.

32. Place the cylinder head on engine. Coat the head bolt threads with water-resistant sealer and install them.

33. Torque the bolts in sequence (Fig. 12) to 75 ft-lbs, then to 105 ft-lbs and finally to specifications. When the cylinder head bolts have been tightened by this procedure, it is not necessary to retorque bolts after extended operation.

34. Coat the cylinder head mating surfaces of exhaust manifold with light film of graphite grease.

35. Position the exhaust manifolds and lifting brackets on the cylinder heads and install the attaching bolts and tab washers. Install the heat shroud mounting studs in the first and sixth bolt holes from the front of right manifold. Install the lifting brackets on the third exhaust port from front, both sides. Torque the attaching bolts to specifications, working from center to ends. Lock the bolts by bending the washer tab over the flat on the bolt.

36. Install the spark plugs.

37. Use hydraulic valve lifter leak-down tester to fill the lifters with test fluid. Coat each valve lifter and bore with heavy engine oil MS to provide initial lubrication. Place each lifter in the bore from which it was removed.

38. Coat both ends of push rods with Lubriplate or equivalent. Install the push rods in original positions. Apply Lubriplate or equivalent to valve stem tips. Install rocker arms over push rods. Perform valve clearance adjustment as detailed under Valve Clearance Adjustment.

39. Clean the mating surfaces of

the intake manifold, cylinder heads and cylinder block.

40. Coat the intake manifold and cylinder block seal surfaces with quick setting adhesive. Apply a thin bead of non-hardening sealer at four junction points of the head and block seal surfaces.

41. Position new seals on the cylinder block and new gaskets on the cylinder heads with gaskets interlocked with seal tabs. Apply a non-hardening sealer at four junction points of seals and gaskets. Be sure holes in gaskets are aligned with holes in cylinder heads.

42. Carefully lower the intake manifold on cylinder block and cylinder heads. After the intake manifold is in place, run a finger around seal area to make sure that seals are in place. If seals are not in place, remove the intake manifold and re-position seals.

43. Be sure that holes in manifold gaskets and manifold are in alignment. Install the intake manifold attaching bolts and stud nuts, and torque them to specifications in sequence (Fig. 9). Retorque the bolts and stud nuts in sequence with manifold warm, after engine is installed and road tested.

44. Install the water pump by-pass hose. Slide the clamp into position and tighten the clamp.

45. Rotate the crankshaft until No. 1 piston is on TDC after compression stroke. Place the distributor in the block with the rotor at No. 1 firing position and points open. Install the hold down clamp.

46. Install the ignition coil.

47. Clean the valve rocker arm covers and cylinder head gasket surfaces. Apply oil-resistant sealer to one side of new cover gaskets. Lay the cemented side of gaskets in place in covers.

48. Position the covers on the cylinder heads. Make sure that gasket seats evenly all around head. Install the bolts. Torque the bolts to specifications. Two minutes later, torque the bolts to same specifications.

49. Install the crankcase ventilation

system regulator valve and hose.

50. Install the distributor cap. Position the spark plug wires in the brackets on the valve rocker arm covers. Connect the spark plug wires and coil wire. Connect the distributor vacuum line.

51. Connect the carburetor fuel inlet line and pump inlet line.

52. Clean the oil filter gasket surface. Coat the gasket on the filter with oil. Place the filter in position and hand tighten until the gasket contacts adapter face; then tighten 1/2 turn more.

53. Install the rear cover plate on the cylinder block.

54. Coat the threads of the flywheel attaching bolts with oil-resistant sealer. Position the flywheel and reinforcing plate (reinforcing plate used only with automatic transmission) on crankshaft flange. Install and torque the bolts to specifications.

55. After the engine has been installed, adjust the ignition timing, carburetor fuel mixture and the engine idle speed.

## 5 SPECIFICATIONS

### GENERAL SPECIFICATIONS

Engine	Compression Ratio	Bore and Stroke	Taxable Horsepower	Brake Horsepower	Gross Torque Ft-Lbs
429-2V	10.5:1	4.36 x 3.590	60.82	320 @ 4400	460 @ 2200
429-4V	11.0:1			360 @ 4600	476 @ 2800
460	10.5:1	4.36 x 3.850	60.83	365 @ 4600	500 @ 2800

### GENERAL SPECIFICATIONS (Continued)

Engine	Compression Pressure PSI (Sea Level) @ Cranking Speed①	Engine Idle Manifold Vacuum①	Oil Pressure-Hot @ 2000 RPM	Firing Order	Belt Tension (Ft-Lbs)②
429	When checking compression, take the highest compression reading and compare it to the lowest reading. The lowest reading must be within 75% of the highest.	17	35-60	1-5-4-2-6-3-7-8	New 140 Used 110
460					

① See Compression Pressure Limit Chart Part 21-01  
 ② Minimum inches of Mercury @ specified engine RPM (sea level). This includes automatic transmission in neutral. Subtract 1 inch of Mercury for engines equipped with dual diaphragm distributors.  
 ③ All belts.

### ENGINE PERFORMANCE SPECIFICATIONS

Engine	Curb Idle RPM①	Fast Idle RPM	Initial Ignition Timing②
429	Standard Transmission 850/500 Automatic Transmission 600	Standard Transmission① 1400 Automatic Transmission 1400	6°
460	Automatic Transmission 600	Automatic Transmission 1250	10°
Headlamps on high beam, and air conditioner off Distributor vacuum line disconnected			

### ENGINE PERFORMANCE SPECIFICATIONS

Engine	Initial Ignition Timing BTDC	Dwell Angle at Idle Speed	Distributor Point Gap	Spark Plug Gap	Spark Plug Number
429-2V	6°	①	①	0.035	BF-42
429-4V	6°	①	①		BF-42③
460-4V	10°	①	①		BF-42

① Dual diaphragm distributor with single points—24-29° dwell angle, 0.021 inch point gap.

Single diaphragm distributor with single points—26-31° dwell angle, 0.017 inch point gap.

③ Thunderbird use BRF-42

### ENGINE PERFORMANCE SPECIFICATIONS (Continued)

ENGINE	Anti-Stall Dashpot Clearance		Automatic Choke Setting		ACCELERATOR PUMP SETTING				IDLE	
					Pump Link		Lever Position		AIR-FUEL RATIO	
	Manual	Auto-matic	Manual	Auto-matic	Manual	Auto-matic	Manual	Auto-matic	Manual	Auto-matic
429-2V		1/8①		2-Rich		Inboard				
429-4V	Solenoid	0.070	Index	Index	0.425②	0.480	#2	#2		
460-4V		0.100		1-Rich		0.425				
w/A.C. — Solenoid										

## CYLINDER HEAD

Engine	Combustion Chamber Volume	Valve Guide Bore Diameter (Standard Intake and Exhaust)	Valve Seat Width		Valve Seat Angle	Valve Seat Runout (Maximum)	Valve Arrangement (Front to Rear)	Rocker Arm Stud Bore Dia Std	Gasket Surface Flatness ①
			Intake	Exhaust					
429	74.2-77.2	0.3433-0.3443	0.060-0.080	0.060-0.080	Intake and Exhaust 45°	0.0015	Right I-E-I-E-I-E-I-E Left E-I-E-I-E-I-E-I		0.003 inch In Any 6 inches
460									0.007 Overall

① Head Gasket Surface Finish RMS ..... 90-150

## VALVE ROCKER ARMS, ROCKER ARM SHAFT, PUSH RODS AND TAPPETS

Engine	Rocker Arm Shaft O.D.	Rocker Arm To Rocker Shaft Clearance	Rocker Arm Bore Diameter	Rocker Arm Lift Ratio	Valve Push Rod (Maximum Runout)	VALVE TAPPET OR LIFTER		
						Standard Diameter	Clearance To Bore ①	Hydraulic Lifter Leardown Rate
429-460				1.75:1	0.015	0.8742 0.8745	0.0005 0.0020	5-50 Seconds Maximum—Measured at 1/16 Inch plunger travel

① Wear Limit -0.005

## VALVE SPRINGS

Engine	Valve Spring Pressure Lbs @ Specified Length			Valve Spring Free Length Approximate	Valve Spring Assembled Height Pad to Retainer	Valve Spring Out-of-Square (Maximum)
	Pressure	Wear Limit				
429	76-84 @ 1.810	68 @ 1.810		2.03	1 51/64-1 53/64	5/64 (.078)
460	240-266 @ 1.330	216 @ 1.330				

## VALVES

Engine	Valve Stem To Valve Guide Clearance		Valve Clearance Hydraulic Lifters		Valve Head Diameter		Valve Face Angle ②	Minimum Allowable Valve Stem Tip Length
	Intake	Exhaust	Allowable	Desired	Intake	Exhaust		
429	0.0010-	0.0010-						
460	0.0027①	0.0027①	0.075-0.175	0.125	2.075-2.090	1.646-1.661	Intake and Exhaust 44°	

① Wear Limit 0.0045

② Wear Limit 0.0047

③ Valve face runout ..... Maximum 0.0020

## VALVES (Continued)

Engine	Valve Stem Diameter							
	Standard		0.003 Oversize		0.015 Oversize		0.030 Oversize	
	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust
429	0.3 416-	0.3416-	0.3446-	0.3446-	0.3566-	0.3566-	0.3 716-	0.3716-
460	0.3423	0.3223	0.3453	0.3453	0.3573	0.3573	0.3723	0.3723

## CAMSHAFT

Engine	Lobe Lift ①		Theoretical Valve Lift		Camshaft		Camshaft Journal To Bearing Clearance	
	Intake	Exhaust	Intake	Exhaust	End Play	Wear Limit	Clearance	Wear Limit
429	0.2530	0.2780	0.4430	0.4860	0.001-0.006	0.012	0.001-0.003	0.006
460								

① Maximum allowable lobe lift loss ..... 0.005

**CAMSHAFT (Continued)**

Item	Bearing	429, 460	Item	Bearing	429, 460	Item	429, 460					
Camshaft Journal Diameter— Standard①	(No. 1)	2.1238-2.1248	Camshaft Bearings Inside Diameter	(No. 1)	2.1258-2.1268	Camshaft Bearing Location②	0.0400- 0.0600					
	(No. 2)			(No. 2)								
	(No. 3)			(No. 3)								
	(No. 4)			(No. 4)								
	(No. 5)			(No. 5)								
① Camshaft journal maximum runout ..... 0.005 Camshaft journal maximum out-of-round ..... 0.0010												
② Distance in inches that the front edge of the bearing is installed towards the rear from the front face of the cylinder block.												

**CAMSHAFT VALVE TIMING**

Engine	Intake Valve		Exhaust Valve		Timing Chain Deflection (Maximum)
	Opens	Closes	Opens	Closes	
429					0.006 Inch @ 20° ATC
460	0.004 Inch @ 16° BTC	0.006 Inch @ 60° ABC	0.004 Inch @ 70° BBC	0.006 Inch @ 61° ATC	

**CAMSHAFT DRIVE MECHANISM**

Engine	Camshaft Gear To Crankshaft Gear Backlash	CAMSHAFT GEAR OR SPROCKET		CRANKSHAFT GEAR OR SPROCKET		Timing Chain Deflection (Maximum)
		Face Runout TIR Max.	Assembled Face Runout TIR Max.	Face Runout TIR Max.	Assembled Face Runout TIR Max.	
429						
460			0.008	0.001	0.006	0.500

**CYLINDER BLOCK**

Engine	Cylinder Bore Diameter①②	Cylinder Bore Diameter 0.003 OS	Tappet Bore Diameter	Main Bearing Bore Diameter	Cylinder Block Distributor Shaft Bearing Bore Diameter	Head Gasket Surface Flatness③
429						0.003 inch in any 6 inches or 0.007 inch
460	4.3600-4.3632	4.3632-4.3636	0.8752-0.8767	3.1922-3.1930	0.5155-0.5170	Overall
① Maximum out-of-round ..... 0.001				② Head gasket surface finish RMS ..... 90-150		
Wear Limit ..... 0.005				③ Maximum Taper ..... 0.001		
Cylinder bore surface finish RMS ..... 15-35				Wear Limit ..... 0.005		

**CRANKSHAFT AND FLYWHEEL**

Engine	Main Bearing Journal Diameter④	Main Bearing Journal Runout- Maximum	Main Bearing Journal Thrust Face Runout	Main Bearing Journal Taper Max	Thrust Bearing Journal Length	Main Bearing Surface Finish RMS Maximum	
						Journal	Thrust Face
429		0.002					
460	2.9994-3.0002	0.003 Wear Limit 0.003	0.001	0.0003 Per Inch	1.124-1.126	12	25 Front 23 Rear
④ Wear Limit 0.0035							
⑤ Connecting rod and main bearing journal out-of-round maximum 0.0004 (all engines)							

**CRANKSHAFT AND FLYWHEEL (Continued)**

Engine	Connecting Rod Journal Diameter①	Connecting Rod Bearing Journal Maximum Taper	Crankshaft Free End Play	Crankshaft To Rear Face Of Block Runout TIR Max	Flywheel Clutch Face Runout	Flywheel OD Runout Transmission	
						Standard	Automatic
429		0.0004					
460	2.4992-2.5000	Per Inch	0.004-0.008	0.005	0.010	0.018	0.017

①Connecting rod and main bearing journal out-of-round maximum 0.0004

**CRANKSHAFT BEARINGS**

Engine	Connecting Rod Bearings			Main Bearings		
	To Crankshaft Clearance		Wall Thickness-Standard②	To Crankshaft Clearance		Wall Thickness-Standard②
	Desired	Allowable		Desired	Allowable	
429						
460	0.0008-0.0015	0.0008-0.0026	0.0756-0.0761	0.0005-0.0015	0.0005-0.0025	0.0955-0.0958

②0.002 U.S. Thickness ..... Add 0.0010 to Standard Thickness

②0.002 U.S. Thickness ..... 0.0966-0.0971

**CONNECTING ROD**

Engine	Piston Pin Bore Or Bushing ID③	Connecting Rod Bearing Bore Diameter④	Connecting Rod Length Center To Center	Connecting Rod Alignment Maximum Total Difference⑤		Connecting Rod Assembly (Assembled To Crankshaft)	
				Twist	Bend	Side Clearance	Wear Limit
429, 460	1.0386-1.0393	2.6522-2.6530	6.6035-6.6065	0.012	0.004	0.010-0.020	0.023

③Piston pin bushing or bore Maximum out-of-round ..... 0.003  
 Maximum taper ..... 0.0005

④Connecting rod bearing bore maximum out-of-round and taper ..... 0.0004  
 ⑤Pin bushing and crankshaft bearing bore must be parallel and in the same vertical plane within the specified total difference at ends of 8-inch long bar measured 4 inches on each side of rod.

**PISTON**

Engine	Diameter⑥			Piston To Cylinder Bore Clearance	Piston Pin Bore Diameter	Ring Groove Width	
	Coded Red	Coded Blue	0.003 Oversize			Upper Compression Ring	Lower Compression Ring
429, 460	4.3585-4.3591	4.3597-4.3603	4.3609-4.3615	0.0014-0.0022	1.0402-1.0405	0.080-0.081	0.080-0.081

⑥Measured at the piston pin bore centerline at 90° to the pin bore.

**PISTON PIN**

Engine	Diameter				To Piston Clearance ⑦	To Connecting Rod Bushing Clearance
	Length	Standard	0.001 Oversize	0.002 Oversize		
429, 460	3.290-3.310	1.0400-1.0403			0.0001-0.0003	⑧

⑦Wear Limit 0.0008

⑧Interference Fit

**PISTON RINGS**

Engine	Ring Width		Side Clearance		Ring Gap Width		Oil Ring ⑨	
	Compression Ring		Compression Ring⑩		Oil Ring	Compression Ring		
	Top	Bottom	Top	Bottom		Top		
429, 460	0.077-0.078	0.077-0.078	0.002-0.004	0.002-0.004	Snug	0.010-0.020	0.010-0.020	0.010-0.035

⑨Wear Limit ..... 0.006

⑩Steel Rail

**OIL PUMP**

Engine	Rotor-Type Oil Pump Relief Valve Spring Tension Lbs @ Specified Length	Drive Shaft To Housing Bearing Clearance	Relief Valve Clearance	Rotor Assembly End Clearance	Outer Race To Housing (Radial Clearance)
429, 460	20.6-22.6 @ 2.49	0.0015-0.0029	0.0015-0.0029	0.0011-0.0041	0.006-0.013

**APPROXIMATE OIL PAN CAPACITIES①**

Engine	US Measure	Imperial Measure	Engine	US Measure	Imperial Measure
429	5 Quarts	4 Quarts	460	5 Quarts	4 Quarts

① Includes one quart with filter replacement

**TORQUE LIMITS**

Engine	Cylinder Head Bolts			Oil Pan To Cylinder Block	Manifolds To Cylinder Head		Water Outlet Housing	Distributor Vacuum Control Valve	Flywheel To Crankshaft
	Step 1	Step 2	Step 3		Intake	Exhaust			
429, 460	75	105	130-140	9-11 (5/16-18)	25-30	28-33	12-15	15-18	75-85

**TORQUE LIMITS (Continued)**

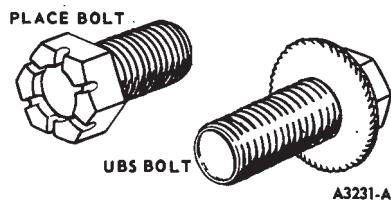
Engine	Main Bearing Cap Bolts	Oil Pan Drain Plug	Oil Pump To Cylinder Block	Oil Pump Cover Plate	Oil Filter Adapter To Cylinder Block	Oil Filter To Adapter Or Cylinder Block	Cylinder Front Cover
429							
460	95-105	20-30	20-25	6-9	60-100	With grease on the gasket surface, hand-tighten until gasket contacts adapter face, then tighten 1/2 turn more.	12-15

**TORQUE LIMITS (Continued)**

Engine	Water Pump To Cylinder Block Or Front Cover	Camshaft Sprocket To Camshaft	Camshaft Thrust Plate In Block	Damper Or Pulley To Crankshaft	Connecting Rod Nuts	Valve Rocker Arm Cover
429						
460	12-15	40-45	9-12	70-90	40-45	5-6

**TORQUE LIMITS (Continued)**

Engine	Oil Inlet Tube To Oil Pump	Fuel Pump To Cylinder Block Or Cylinder Front Cover	Pulley To Damper Bolts	Air Manifold To Cylinder Head-Thermactor	Check Valve To Air Manifold Or Supply Tube-Thermactor	Adjusting Arm To Air Pump-Thermactor	Air Pump Mounting Bolts-Thermactor	Air Pump Drive Pulley To Pump Hub-Thermactor
429								
460	Press Fit	20-24	UBS Bolts 25-35 Place Bolts 35-45	Check	Check	16-20	16-26	7-9



**TORQUE LIMITS (Continued)**

Engine	Valve Rocker Shaft Support To Cylinder Head	Valve Rocker Arm Stud To Cylinder Head	Valve Push Rod Chamber Cover	Valve Rocker Arm Adjusting Nut
429		65-75		Valve Rocker Arm Stud Nut 18-22 ft-lbs After Nut Contacts Shoulder
460				

**ENGINE SUPPORT TORQUE LIMITS-FT-LBS**

Front Supports	Ford Mercury Meteor	Fairlane Montego	T-Bird	Lincoln Continental	Continental Mark III
Insulator to Engine	35-40		35-50		35-50
Support Bracket to Engine		35-60		35-50	
Support Bracket to Crossmember	20-30	20-30	20-30		20-30
Insulator Through Bolt Nut	20-30	20-30	15-25	15-25	15-25
Support Bracket to Insulator		30-50			

**Rear Supports**

Insulator to Transmission Extension Housing	40-50	30-45	40-60	20-30	40-60
Support to Crossmember	20-30	30-50	12-20	30-45	12-20
Crossmember to Side Rail	70-100	50-70	70-100	70-100	70-100

**LUBRICANTS**

Exhaust Control Valve Lubricant	COAZ-19A501-A, R-149-A
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**SEALERS**

Loctite (thread locking compound)	C3AZ-19554-A
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**TORQUE LIMITS FOR VARIOUS SIZE BOLTS**

Caution: If any of the torque limits listed in this table disagree with any of those listed in the preceding tables, the limits listed in the preceding tables prevail.						
Size (Inches)	1/4-20	1/4-28	5/16-18	5/16-24	3/8-16	3/8-24
Torque (Ft-lbs)	6-9	6-9	12-15	15-18	23-28	30-35
Size (Inches)	7/16-14	7/16-20	1/2-13	1/2-20	9/16-18	5/8-18
Torque (Ft-lbs)	45-50	50-60	60-70	70-80	85-95	130-145

# PART 21-08 429 CID High Output Engines

APPLIES TO FAIRLANE, MONTEGO, MUSTANG AND COUGAR ONLY

COMPONENT INDEX	Page	COMPONENT INDEX	Page
CAMSHAFT—BOSS ONLY .....	08-01	OIL COOLER—SCJ AND BOSS ONLY .....	08-06
Installation .....	08-01	Installation .....	08-06
Removal .....	08-01	Removal .....	08-06
CYLINDER FRONT COVER—BOSS ONLY .....	08-03	SEALS, VALVE STEM .....	08-09
Installation .....	08-03	Installation .....	08-09
Removal .....	08-03	Removal .....	08-09
CYLINDER HEADS—BOSS ONLY .....	08-04	SPECIFICATIONS .....	08-10
Installation .....	08-05	TAPPETS, VALVE—BOSS ONLY .....	08-03
Removal .....	08-04	Installation .....	08-04
ENGINE ASSEMBLY .....	08-01	Removal .....	08-03
Description .....	08-01	VALVES .....	08-07
EMISSION CONTROL SYSTEM .....	08-07	Adjustment .....	08-07
MANIFOLD, EXHAUST—BOSS ONLY .....	08-06	SCJ .....	08-07
Installation .....	08-06	BOSS .....	08-08
MANIFOLD, INTAKE—BOSS ONLY .....	08-02	VALVE ROCKER ARM COVERS—BOSS ONLY .....	08-04
Installation .....	08-02	Installation .....	08-04
Removal .....	08-02	Removal .....	08-04

## 1 ENGINE ASSEMBLY

### DESCRIPTION

Three different 429 CID high performance engines are available for the 1970 models. They are, the Cobra Jet, Super Cobra Jet and the BOSS.

Only the service procedures unique to these engines will be covered in this Part. With the exception of the four-bolt main bearing caps the procedure for servicing the cylinder assembly (chart block) is basically the same as

the regular 429 CID engine covered in Part 21-07. The main differences between the three engines are, the intake manifolds, valve train, cylinder heads and the exhaust manifolds.

## 2 IN-VEHICLE ADJUSTMENTS AND REPAIRS

### CAMSHAFT—BOSS ONLY

#### REMOVAL

1. Disconnect the battery ground (negative) cable.
2. Remove the grille, grille center support and the two front fender apron-to-dash panel braces.
3. Remove the cylinder front cover.
4. Remove the tappets.
5. Crank the engine until the timing marks on the sprockets are aligned (crank sprocket up and cam sprocket down).
6. Remove the camshaft sprocket cap screw, washer, and fuel pump ec-

centric. Slide the timing chain and sprockets forward, and remove them as an assembly.

7. Remove the intake manifold.
8. Remove the camshaft thrust plate attaching bolts and carefully remove the camshaft from the front of engine. Do not damage camshaft bearings.

#### INSTALLATION

1. Lubricate the new camshaft journals with heavy oil MS and apply Lubriplate or equivalent to the cam lobes. Carefully slide the camshaft into position.

2. Install the camshaft thrust plate. Torque bolts to specification.

3. Push the camshaft toward the rear of the engine to check end play. Install a dial indicator so that the indicator point is on the front face of the camshaft. Zero the dial indicator. Position a large screwdriver between the camshaft and the block, pull the camshaft forward and release it to obtain the end play. Compare the dial indicator reading with specified limits. If end play is excessive, replace the thrust plate. Remove the dial indicator.

4. Assemble the timing chain and sprockets so that the sprocket timing

marks point directly toward each other. Install chain and sprockets as an assembly to crankshaft and cam-shaft. Verify proper alignment of timing marks after installation.

5. Install the fuel pump eccentric, camshaft sprocket cap screw, and washer. Torque the cap screw to specifications. Lubricate the timing chain with engine oil.

6. Lubricate the tappets and the bores with heavy oil MS before installation. Install the tappets in the bores from which they were removed.

7. Install the intake manifold.

8. Install the cylinder front cover and adjust the valve clearance.

9. Fill the cooling system with specified coolant.

10. Connect the battery ground (negative) cable.

11. Start the engine and check for leaks. Set the ignition timing and the carburetor to specifications.

## INTAKE MANIFOLD—BOSS ONLY

### REMOVAL

1. Disconnect the battery ground (negative) cable. Remove the air cleaner.

2. Drain the cooling system.

3. Disconnect the heater hose from the intake manifold and position it out of the way.

4. Disconnect the positive crankcase ventilation hose from the valve rocker arm cover on the right side of the engine. Disconnect and tag all vacuum lines from the rear of the intake manifold.

5. Twist and pull the moulded spark plug wire cap from each plug. Remove plug wires from the brackets on the valve rocker arm covers. Disconnect the high tension lead from coil and remove distributor cap and wires from the distributor as an assembly.

6. Disconnect all distributor vacuum lines from the carburetor and the vacuum control valves. Tag them for proper installation.

7. Disconnect the accelerator linkage from the carburetor. Remove the bolts that attach the accelerator linkage bellcrank. Disconnect the linkage spring and position linkage to one side.

8. Disconnect the fuel line from the carburetor.

9. Disconnect the wiring harness from the coil battery terminal, engine temperature sending unit, oil pressure sending unit, and other connections, as necessary. Disengage the wiring

harness from the retaining clips at the left valve rocker arm cover bolts. Position wiring harness out of the way.

10. Disconnect the Thermactor air bypass valve from the mounting bracket and place it to one side.

11. Remove the coil and bracket assembly.

12. Disconnect the manifold heat inlet and outlet tubes from the rear of the manifold and from the exhaust pipe.

13. Remove the distributor from the engine.

14. Remove the intake manifold attaching bolts, then remove manifold and carburetor as an assembly. If necessary to pry the manifold away from cylinder heads, do not damage the gasket sealing surfaces.

15. Remove the intake manifold. Discard the gaskets and seals.

### INSTALLATION

1. Remove all gasket material from the cylinder head or rocker arm cover sealing surface.

2. Coat the cylinder block seal surfaces, cylinder head intake manifold gasket surface around intake manifold hold-down bolt holes, with quick-drying adhesive sealer. Apply a thin bead of non-hardening sealer at junction of cylinder block sealing surfaces and cylinder heads (4 places).

3. Position new intake manifold gaskets on the cylinder heads, carefully aligning holes in gaskets with holes

in cylinder heads. Coat underside of front and rear seals with quick-drying adhesive sealer and fit seals to cylinder block, aligning seal tabs in notches in gaskets. Apply bead of non-hardening sealer over four (4) junction points of seals and gaskets.

4. Carefully lower intake manifold into position over four (4) studs in ends of cylinder heads. When intake manifold is in place, run finger around seal area to be sure seals are in place. If seals have shifted, remove manifold and reposition seals.

5. Be sure intake manifold gaskets are properly aligned. Then install attaching bolts and nuts snugly to manifold. Torque the bolts and nuts to specifications as shown in Fig. 1.

6. Rotate the crankshaft damper until No. 1 piston is at TDC at end of compression stroke. Position the distributor in the cylinder block with the rotor at No. 1 firing piston with the points just starting to open. Install the hold-down clamp and bolt.

7. Connect the heater hose to the intake manifold and water pump.

8. Connect the ventilation hose to the valve rocker arm cover on the right side of engine.

9. Install the coil and mounting bracket on the intake manifold. Secure the wiring harness to the retaining clips on the left rocker arm cover.

10. Position the Thermactor air bypass valve on the mounting bracket and secure with the retaining clamp.

11. Connect the manifold heat inlet

### FRONT

	14 •	• 13
	8 •	• 7
Left Side	2 •	• 3 Right Side
of	10 •	• 9 of
Manifold	4 •	• 1 Manifold
	6 •	• 5
	12 •	• 11

Step 1 — Bolt torque specifications (1 through 10)  
4-6 ft-lbs.

Step 2 — Nut torque specifications (11 through 14)  
8-10 ft-lbs.

Step 3 — Torque bolts and nuts (1 through 14)  
in sequential order to 15-20 ft-lbs.

Step 4 — Torque bolts and nuts (1 through 14)  
in sequential order to 25-30 ft-lbs.

Step 5 — Retorque manifold bolts and nuts (1 through 14)  
in sequential order to 25-30 ft-lbs.

CA1015-A

FIG. 1—Intake Manifold Tightening Sequence

and outlet tubes to the rear of the intake manifold and to the exhaust pipe.

12. Position the accelerator linkage and secure it to the manifold. Attach the accelerator linkage bell crank. Install the linkage springs and connect the linkage to the carburetor.

13. Connect the vacuum lines to their respective intake manifold connection.

14. Clip the distributor cap to the distributor. Connect the spark plug wires to the spark plugs and fit the wires into the brackets on the valve rocker arm covers. Connect the coil high tension lead to the coil.

15. Close the radiator drain cock. Fill and bleed the cooling system. Connect the battery ground cable.

16. Start the engine. Check and adjust the ignition timing to specifications with the vacuum lines disconnected from the distributor and plugged. Connect the distributor vacuum lines to their respective ports.

17. Operate engine at fast idle and check for coolant and power steering fluid leaks. Bleed power steering system and refill reservoir, as ney. Recheck coolant level and refill, as necessary.

18. Start the engine and allow it to reach normal operating temperature. Then retorque the manifold attaching bolts to specification.

19. Check and adjust carburetor idle speed and mixture to specification.

20. Install air cleaner.

#### CYLINDER FRONT COVER—BOSS ONLY

##### REMOVAL

1. Disconnect the battery ground (negative) cable.

2. Drain the cooling system and remove the air cleaner.

3. Remove the fan from the water pump.

4. Disconnect the radiator upper and lower hose from the engine.

5. Remove the radiator and hoses from the engine compartment as an assembly.

6. Loosen the alternator attaching bolts, Thermactor pump drive belt and power steering pump adjustment bolt. Remove the fan and water pump pulley. Remove the Thermactor pump, alternator and power steering pump drive belts.

7. Remove the crankshaft damper attaching bolt and washer. Remove the damper from the crankshaft with

Tool T58P-6316-B.

8. Disconnect the power steering lines from the pump and drain them into a container. Remove the pump from the mounting bracket.

9. Disconnect the heater return hose from the water pump. Loosen the bypass hose at the water pump. Remove the oil level dipstick.

10. Disconnect the fuel inlet and the outlet line from the fuel pump. Plug the fuel inlet line. Remove the fuel pump from the cylinder front cover and discard the gasket.

11. Remove the cylinder front cover attaching bolts. Using a thin bladed knife, cut the oil pan seal flush with the cylinder block face prior to separating the cover from the block.

12. Remove the cylinder front cover and water pump from the cylinder block as an assembly. Discard the cylinder front cover gasket and the oil pan seal.

##### INSTALLATION

1. Clean the oil pan and cylinder front cover gasket surfaces thoroughly. Coat the gasket surface of the oil pan with sealer. Cut and position the required sections of a new seal on the oil pan. Apply sealer at the corners.

2. Coat the gasket surfaces of the block and cover with sealer, and position a new gasket on the block.

3. Drive out the old cylinder front cover seal with pin punch. Clean seal recess in cylinder front cover. Coat new seal with grease. Install seal with Tool T68P-6700-A. After installation, be sure that the seal spring remains in proper position.

4. Install the cylinder front cover to seal alignment tool (T61P-6019-B, or 6059-F) into proper position. It may be necessary to force the cover downward in a manner to slightly compress the pan seal.

5. Coat the threads of the cylinder front cover attaching bolts with oil-resistant sealer, and install them.

6. While pushing in on the alignment tool, torque the oil pan to cover attaching bolts to specifications. Remove alignment tool. Torque the cover attaching bolts to specifications.

7. Apply a white lead and oil mixture to the front of the crankshaft for damper installation.

8. Install the crankshaft damper Woodruff key and install the crankshaft damper with Tool No. T64T-6306-A. Install the damper attaching bolt and washer. Torque it to specification.

9. Position the radiator in the

vehicle and install the radiator upper support to secure radiator. Connect radiator upper and lower hoses.

10. Coat a new fuel pump gasket with oil-resistant sealer and place it on the fuel pump. Install the fuel pump. Remove the plug from the fuel inlet line and connect the fuel lines to the fuel pump and the carburetor.

11. Connect the heater return hose to the water pump. Tighten the water bypass hose clamp at the water pump.

12. Install and connect the power steering pump and lines.

13. Install the water pump pulley and all drive belts.

14. Install the fan assembly on the water pump shaft. Install and tighten the attaching bolts to specifications. Adjust the alternator, Thermactor and power steering drive belts to specifications.

15. Fill the power steering reservoir and bleed the system. Install the oil level dip-stick and replenish or replace the engine oil as required.

16. Fill and bleed the cooling system with the specified coolant.

17. Connect the battery ground (negative) cable.

18. Operate the engine at fast idle and check for coolant, oil and power steering leaks.

19. Check and adjust idle speed and mixture as required.

20. Install the air cleaner.

#### VALVE TAPPETS—BOSS ONLY

##### REMOVAL

The following is applicable for removing one or all of the tappets:

1. Disconnect the battery ground (negative) cable.

2. Remove the intake manifold and carburetor as an assembly.

3. Remove the valve rocker arm covers. If removing the left cover, the brake master cylinder must be disconnected from the booster and moved to one side to provide clearance. Back off the rocker arm adjusting screws for tappets being removed. Then remove the nuts and rocker arms with shafts (keep them in sequence to ensure proper installation).

4. Remove push rods (keep in sequence).

5. Remove the tappets with a magnet. If they are stuck in bores, use plier-type tool (T52T-6500-DJD, or 6500-D) to remove them. Rotate the tappet back and forth to loosen from gum or varnish deposits.

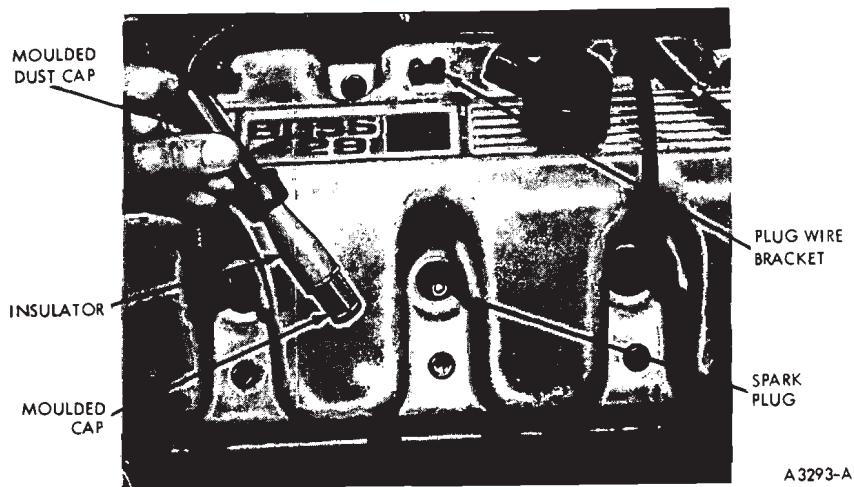


FIG. 2—Removing or Installing Spark Plug Wire

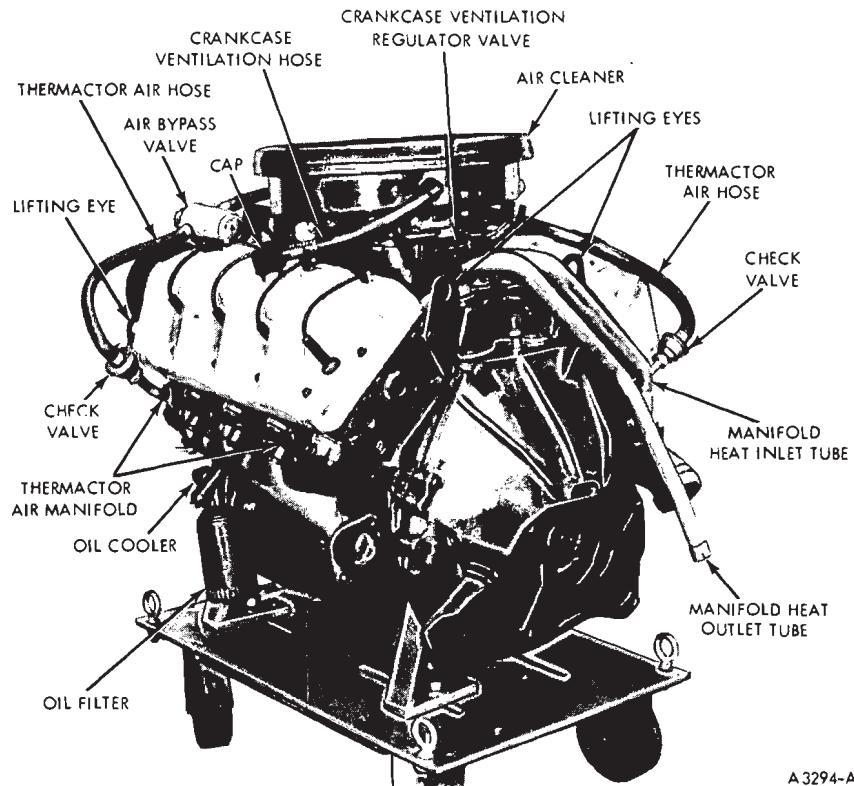


FIG. 3—3/4 Left Rear View of BOSS Engine

**INSTALLATION**

1. Clean the new valve tappets. Check for free fit in bore to which it is to be installed. Lubricate the tappets and bores with heavy oil MS. Install them in their respective bores.

2. Install the push rods in their original position. Apply Lubriplate or equivalent to the valve stem tips.

3. Lubricate the rocker arms and rocker arm shafts with heavy oil MS

before installation. Install the rocker arm and shaft assemblies (with loosened adjusting screws) in original positions. Do not torque until setting the valve clearance.

4. Adjust the valve clearance.
5. Install the intake manifold.
6. Install the valve rocker arm covers.
7. Connect the battery ground (negative) cable.

**VALVE ROCKER ARM COVERS—BOSS ONLY****REMOVAL**

1. Disconnect the battery ground (negative) cable.
2. Remove the cap that connects the crankcase ventilation hose to the left valve rocker arm cover.
3. Remove the air cleaner.
4. If removing the right valve rocker arm cover, lift the crankcase ventilation hose cap from the cover.
5. Lift each plug wire from the bracket (Fig. 2).
6. Disconnect the wires from the spark plugs by twisting and pulling the moulded dust caps.
7. If removing the left valve rocker arm cover, disconnect the brake master cylinder from the booster and move it to one side to provide clearance.
8. Remove the valve rocker arm cover attaching bolts and nuts. Lift the rocker arm covers from the cylinder heads.
9. Clean all gasket material from the cover and cylinder head.

**INSTALLATION**

1. Coat one side of a new valve cover gasket with an oil-resistant sealer and lay the cemented side of the gasket in place on the cover.

2. Install the cover, making sure that the gasket seats evenly around the head.

3. Tighten the cover attaching bolts and nuts evenly and alternately in two steps. First, torque the nuts and bolts to specifications; then, retorque them to the same specifications two minutes after initial tightening.

4. Connect each spark plug wire to its respective plug (Fig. 2). Insert the plug wires into the brackets on the valve cover.

5. Install the cap and crankcase ventilation hose on the valve covers.

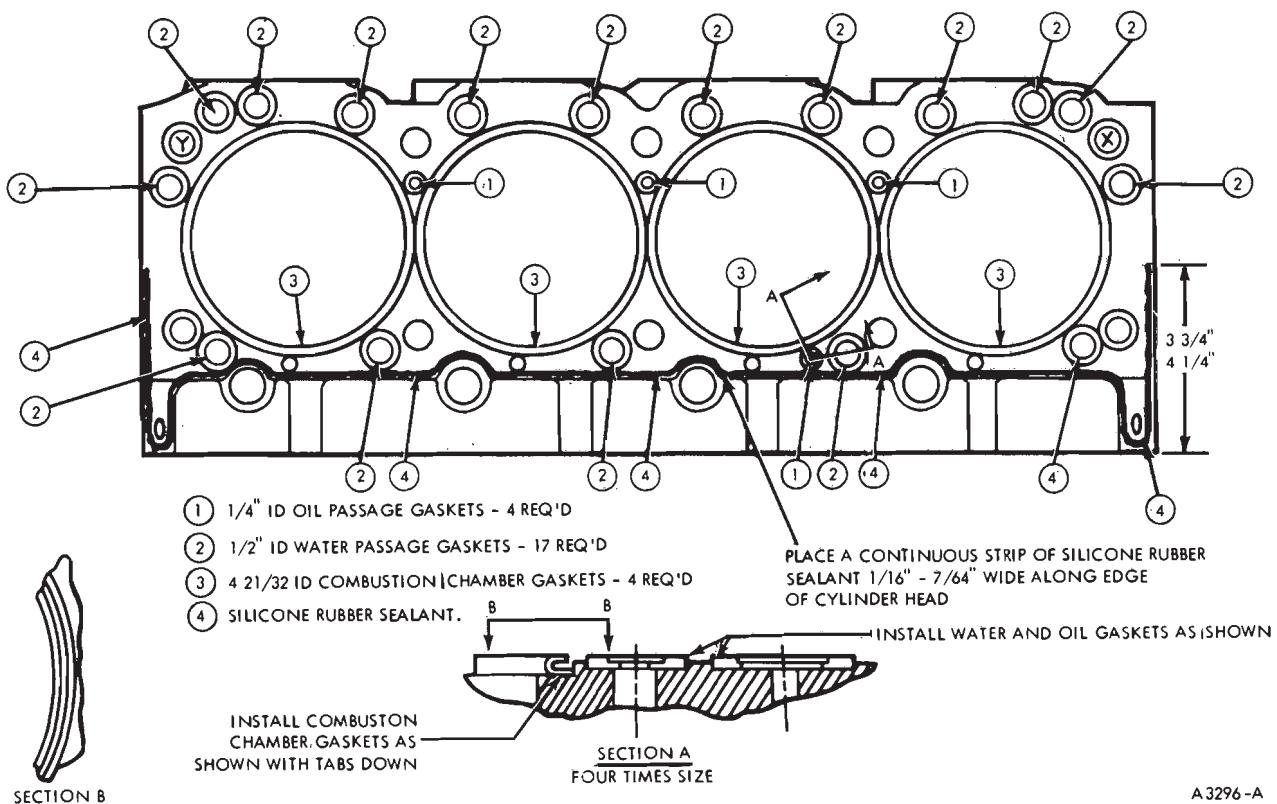
6. If installing the left valve rocker arm cover, install the brake master cylinder on the booster.

7. Install the air cleaner.

8. Connect the battery ground (negative) cable.

**CYLINDER HEADS—BOSS ONLY****REMOVAL**

1. Disconnect the battery ground (negative) cable.
2. Remove both valve rocker arm covers.



Intake Manifold Side

9	5	1	3	7
•	•	•	•	•
•	•	•	•	•
10	6	2	4	8

CA1014-A

FIG. 5—Cylinder Head Tightening Sequence

3. Remove the intake manifold.
4. Back off all rocker arm adjusting screws. Remove all rocker arm shaft attaching nuts from the head being removed. Remove the rocker arms, shafts and pedestals. Keep them in sequence so they can be installed in their original position.
5. Lift the push rods from the cylinder head. Keep them in sequence so they may be installed in their original position.
6. Disconnect the muffler inlet pipe from the exhaust manifold.
7. Disconnect the air hose from the Thermactor check valve (Fig. 3) on the head being removed.

8. Remove the ten cylinder head attaching bolts. Connect a lifting sling to the lifting eye at each end of the cylinder head (Fig. 3). Lift the head from the cylinder block with a hoist.

9. Remove all rubber and steel gaskets from the cylinder head and block.

10. Clean the cylinder head and block mating surfaces thoroughly.

## INSTALLATION

1. Wipe the head and the cylinder block mating surfaces with Chlorathane.

2. Coat the upper end of the cylinder head and the cylinder block to be sealed, with silicone rubber primer (Dow Corning A-4094). Coat all No. 1 and 2 gasket counterbores with quick drying adhesives sealer, to prevent dropping the gaskets while installing the head.

3. Position the four combustion chamber gaskets (3) with the tabs seated down in the counterbore (Fig. 4). The three tabs can be located quickly by rotating the gasket between the finger and thumb to feel the tabs.

4. Press the four 1/4-inch ID gaskets (1) into the cylinder head counterbores with the stepped side

facing up.

5. Press the seventeen 1/2-inch ID gaskets (2) into the cylinder head counterbores with the stepped side facing up.

6. Apply a continuous strip of sealant (4) along the top edge of the cylinder head as shown in Fig. 4.

7. Install a guide pin 9/16-12 x 6 inch at each end of the cylinder block. Lower the head into place over the guide pins being careful not to drop any gaskets from the head.

8. Install but do not tighten eight attaching bolts and flatwashers. Remove the two guide pins and install the two remaining bolts and washers. The attaching bolts should be torqued in three progressive steps. Torque the bolts in the sequence shown in Fig. 5 to 55-60 ft-lbs. Then torque them to 75-80 ft-lbs and finally to 90-95 ft-lbs.

9. Connect the Thermactor air hose to the check valve (Fig. 3).

10. Connect the muffler inlet pipe to the exhaust manifold.

11. Lubriplate both ends of push rods. Install the push rods in their original positions.

12. Lubricate the rocker arms and shafts with heavy oil MS before installing them. Install the rocker arm and shaft assemblies (with loosened adjusting screws) in original positions.

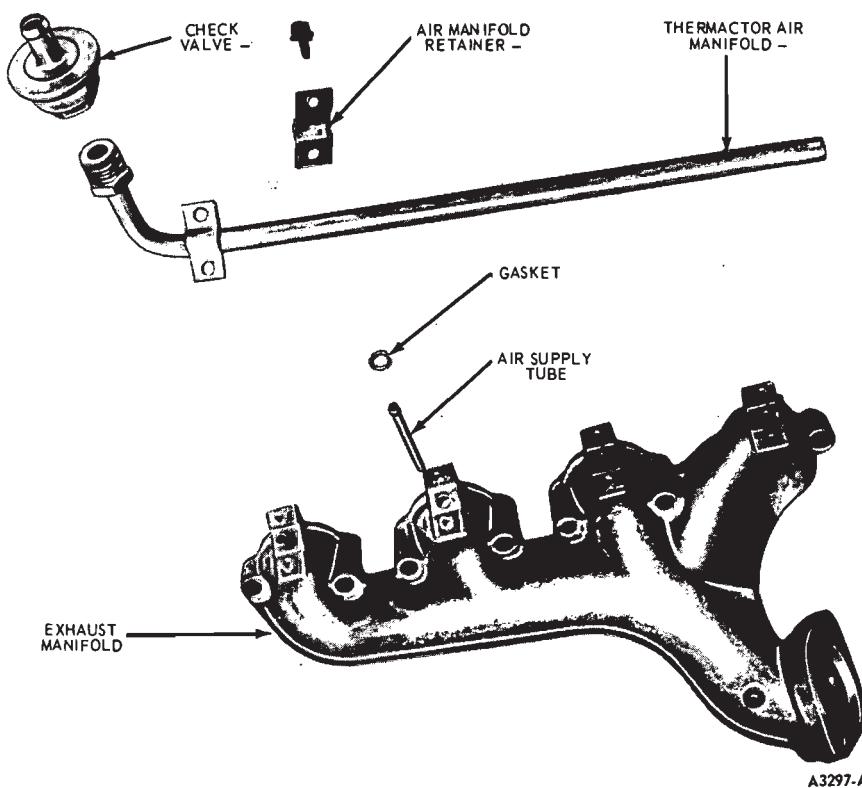


FIG. 6—Exhaust Manifold and Related Thermactor Parts—429 BOSS

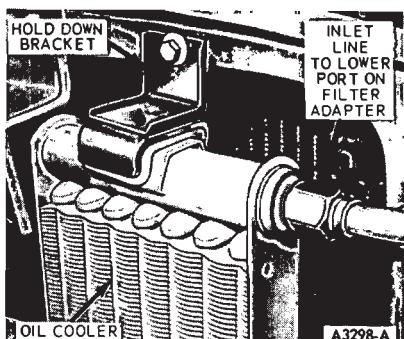


FIG. 7—Engine Oil Cooler Installed

Do not torque at this time.

13. Rotate the crankshaft damper until No. 1 piston is at the TDC at end of the compression stroke. Position the distributor in the cylinder block with the rotor at No. 1 firing position and points just starting to open. Install the hold-down clamp and bolt.

14. Torque the rocker arm shaft nuts on No. 1 cylinder intake and exhaust to specification. Then adjust the clearance to specification (cold) using a feeler gauge between the rocker arm and the valve stem tip. Make sure both ends of the push rod are properly engaged in the tappet and rocker

arm. Torque the adjusting screw lock nuts to specification, while holding the adjusting screw in place.

15. Rotate the crankshaft 90 degrees to position the No. 5 piston at TDC at the end of the compression stroke (watch distributor rotor) and repeat Step No. 14 for No. 5 intake and exhaust rocker arms.

16. Go on through the firing order (1-5-4-2-6-3-7-8), repeating Step No. 14 to adjust each rocker arm.

17. When completed, remove the distributor to prevent possible damage when installing the intake manifold.

18. Install the valve rocker arm covers.

19. Install the intake manifold.

20. Connect the battery ground (negative) cable.

#### EXHAUST MANIFOLD—BOSS ONLY

##### REMOVAL

1. Disconnect the battery ground (negative) cable.

2. Remove the valve cover.

3. Disconnect the air hose from the Thermactor check valve.

4. Remove the air manifold from the exhaust manifold.

5. Disconnect the muffler inlet pipe

from the exhaust manifold.

6. Working from underneath the vehicle, remove the eight exhaust manifold attaching bolts.

7. If removing the left manifold, it may be necessary to disconnect the clutch linkage to provide clearance.

8. Work the manifold rearward and remove it from the engine compartment.

9. Remove the four Thermactor manifold delivery tubes and gaskets from the exhaust manifold.

#### INSTALLATION

1. Position the four Thermactor manifold delivery tubes in the exhaust manifold (Fig. 6).

2. Working from the underside of the vehicle and rear of the engine, position the manifold. Install and torque the eight attaching bolts to specification.

3. Install new gaskets and connect the inlet pipe to the manifold. Torque the nuts to specification.

4. Install and adjust the clutch linkage if it was removed.

5. Place four new Thermactor air manifold delivery tube gaskets on the tubes.

6. Install the Thermactor air manifold and torque the attaching bolts to specification.

7. Connect the air hose to the Thermactor check valve.

8. Install the valve cover.

9. Connect the battery ground (negative) cable.

#### OIL COOLER—SCJ AND BOSS ONLY

##### REMOVAL

1. Disconnect the inlet and outlet lines from the oil cooler and drain them into a container.

2. Remove the hold-down bracket from the top of the cooler (Fig. 7).

3. Lift the cooler from the lower mount.

#### INSTALLATION

1. Position the oil cooler on the lower mount.

2. Install the upper hold-down bracket.

3. Connect the inlet and outlet lines.

4. Fill the crankcase to the proper level with the specified oil.

5. Start the engine and check for oil leaks.

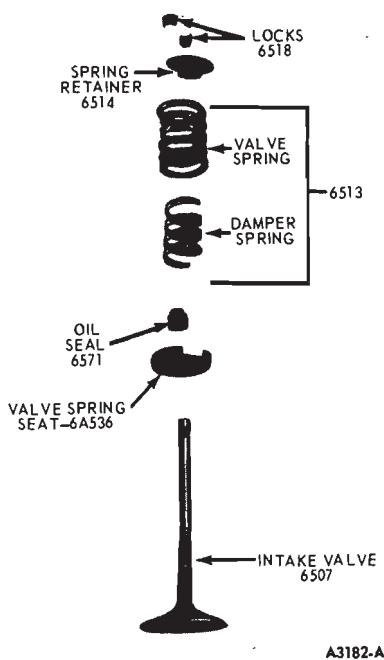


FIG. 8—Valve and Related Parts

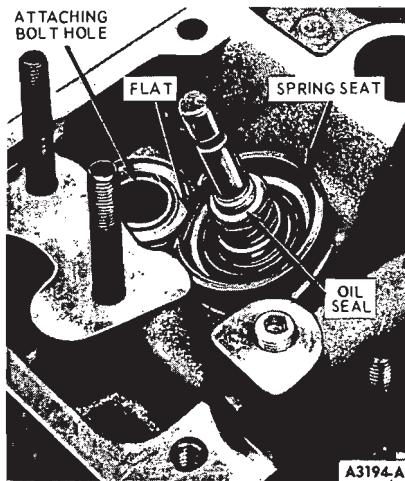


FIG. 9—Valve Spring Seat Location

## EMISSION CONTROL SYSTEM

The Thermactor emission control system used on the SCJ and BOSS engines differ in one respect. A drilled passage is provided in each cylinder head to accommodate the air manifold on the SCJ engines. The air manifolds on the BOSS engines are secured directly to the exhaust manifolds (Fig. 3) with attaching bolts. Replacement of the manifold and air supply tubes is detailed under Exhaust Manifolds.

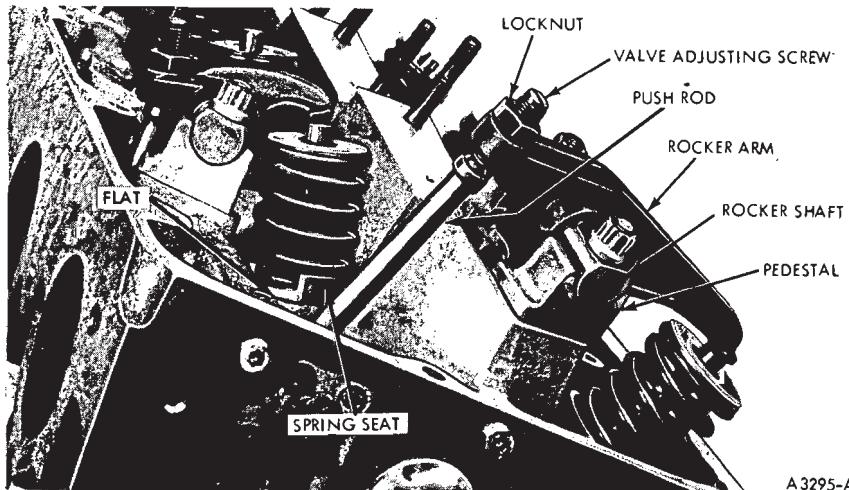


FIG. 10—Valve Clearance Adjustment

## VALVES

The valves in the 429 high output engines are basically the same as those used in other Ford engines, except for dimensions, seals and the valve spring seat (Fig. 8). The valves are replaced in the same manner as before, except that the flat (cut-away) surface of the spring seat must be adjacent to the cylinder head attaching bolts to provide clearance on the 429 BOSS engine (Fig. 9). The valve clearance is adjusted as follows:

### VALVE CLEARANCE ADJUSTMENT

#### SCJ Engine

##### Preliminary (Cold)

If some component of the valve train has been replaced; i.e., rocker arm, push rod, camshaft, etc., it will be necessary to make a preliminary (cold) valve clearance adjustment before starting the engine. If the valve clearance adjustment is made for an engine tune-up, follow the final (hot) adjustment procedure.

The cylinders are numbered from front to rear—right bank, 1-2-3-4; left bank, 5-6-7-8.

The valves are arranged from front to rear, on the left bank E-I-E-I-E-I-E-I, and on the right bank I-E-I-E-I-E-I-E.

**1. Disconnect the brown lead (I terminal) and the red and blue lead (S terminal) at the starter relay. Install an auxiliary starter switch between the battery and S terminals of the starter relay. Crank the engine with**

the ignition switch OFF.

**2. With the crankshaft in the positions given in steps 3, 4 and 5, loosen the lock nut and set the valve clearance (Fig. 10) to specifications with a step-type feeler gauge (go and no go). After adjusting each valve, torque the lock nut to specifications.**

**3. Rotate the crankshaft until No. 1 piston is on TDC at the end of the compression stroke, POSITION A in Fig. 11. Adjust the following valves:**

No. 1 Intake    No. 1 Exhaust  
No. 7 Intake    No. 5 Exhaust  
No. 8 Intake    No. 4 Exhaust

**4. Rotate the crankshaft to POSITION B in Fig. 11. Adjust the following valves:**

No. 5 Intake    No. 2 Exhaust  
No. 4 Intake    No. 6 Exhaust

**5. Rotate the crankshaft to POSITION C in Fig. 11. Adjust the following valves:**

No. 2 Intake    No. 7 Exhaust  
No. 3 Intake    No. 3 Exhaust  
No. 6 Intake    No. 8 Exhaust

#### Final (Hot)

It is very important that the valve clearance be held to the correct specifications because:

If the clearance is set too close, the valve will open too early and close too late, resulting in rough engine idle. Burning and warping of the valves will also occur because the valves cannot make firm contact with the seats long enough to cool properly. If the clearance is excessive, it will cause the valve to open too late and close too early causing valve bounce. In addition, damage to the camshaft lobes is likely because the tappet foot will not follow the pattern of the

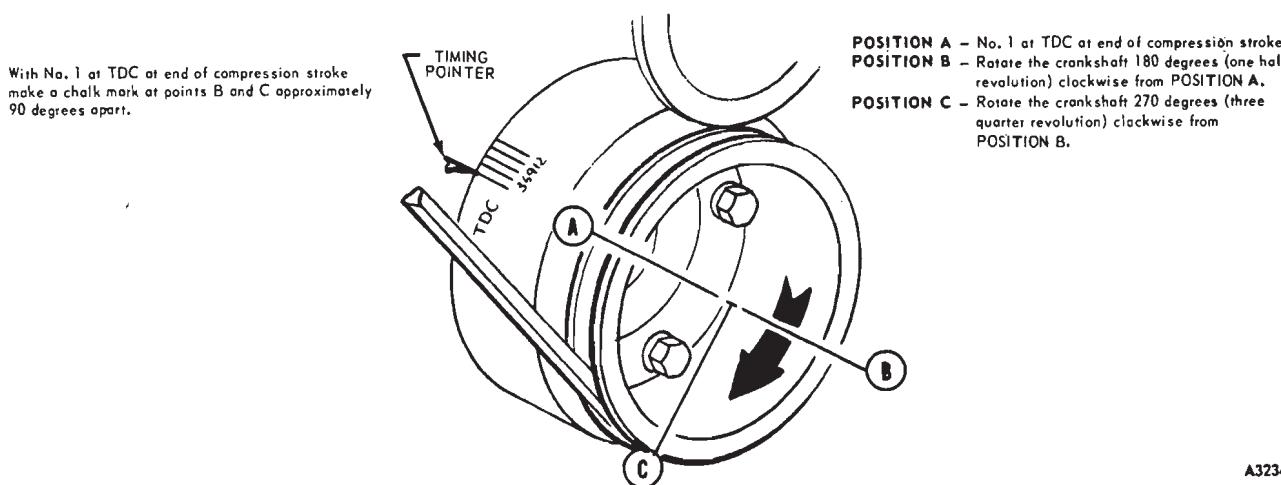


FIG. 11—Position of Crankshaft for Adjusting Valve Lash

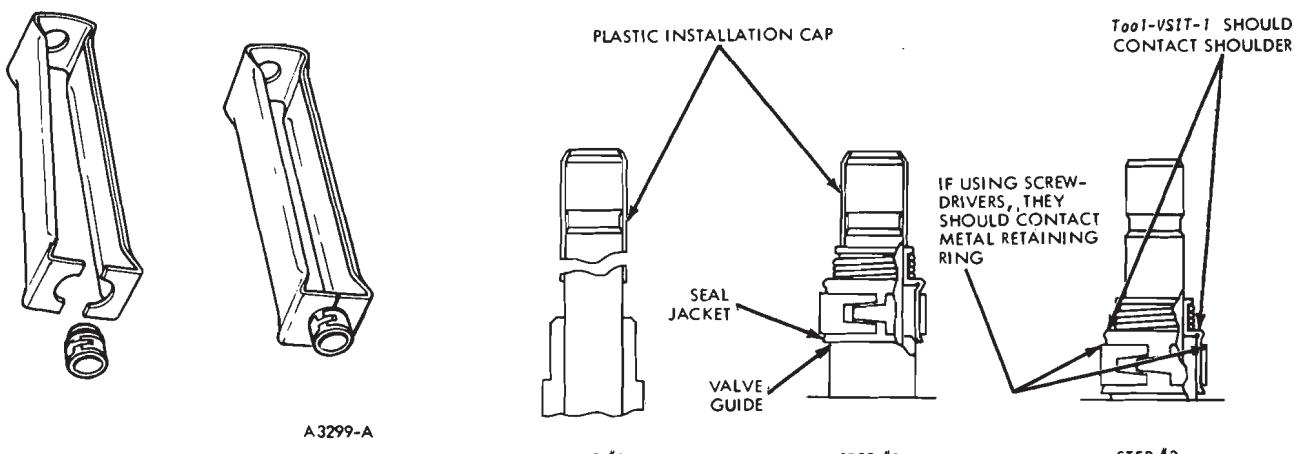


FIG. 12—Valve Stem Seal Installation Tool

camshaft lobe causing a shock contact between these two parts.

1. Be sure the engine is at normal operating temperature before attempting to set the valve clearance.

2. With the engine idling, set the valve clearance (Fig. 11) using a step-type feeler gauge only (go and no go). The final (hot) intake and exhaust valve clearance settings are listed in the Specifications.

3. After adjusting each valve, torque the lock nut to specifications and recheck the valve clearance.

#### BOSS Engine

The valve clearance should be set only when the engine is cold.

1. Remove the valve rocker arm covers.

2. Rotate the crankshaft damper until No. 1 piston is at TDC at end of compression stroke. Position the

STEP #1 WITH VALVES IN HEAD. PLACE PLASTIC INSTALLATION CAP OVER END OF VALVE STEM.

STEP #2 START VALVE STEM SEAL CAREFULLY OVER CAP. PUSH SEAL DOWN UNTIL JACKET TOUCHES TOP OF GUIDE.

STEP #3 REMOVE PLASTIC INSTALLATION CAP. USE INSTALLATION TOOL-VSIT-1 OR SCREWDRIVERS TO BOTTOM SEAL ON VALVE GUIDE.

FIG. 13—Installing Valve Stem Seal

A3302-A

distributor with the rotor at No. 1 firing position and breaker points just starting to open.

3. Torque the rocker arm shaft nuts to the No. 1 cylinder intake and exhaust to specification. Then adjust the clearance to specifications cold, using a feeler gauge between the rocker arm and valve stem tip. Make sure both ends of the push rod are properly engaged in the tappet and rocker arm. Torque the adjusting screw lock nuts to specification while

holding the adjusting screw in place.

4. Rotate the crankshaft 90 degrees to position No. 5 piston at TDC at the end of the compression stroke (watch distributor rotor) and repeat Step No. 5 for No. 5 intake and exhaust rocker arms.

5. Proceed through the firing order (1-5-4-2-6-3-7-8), repeating Step No. 5 to adjust each rocker arm.

6. Install the valve rocker arm covers.

**VALVE STEM SEALS—BOSS ONLY**

The intake and exhaust valve stem seals are a fixed-type design. The seal is held in place on the valve guide by a spring clamp provided on the seal. Seals are serviced in 0.003, 0.015 and 0.030 inch oversize. It is important when installing new seals to install the correct size to match the valve stem.

**REMOVAL**

1. Disconnect the battery ground (negative) cable.
2. Remove the valve spring in the usual manner.
3. Grasp the bottom edge of the valve seal with Perfect Circle Tool

No. VSIT-1 and pull it off the guide and the valve (Fig. 12).

**INSTALLATION**

1. Remove all burrs from the valve stem with a fine stone or crocus cloth.
2. Clean the stem and guide, and lubricate lightly.
3. Place the plastic installation cap (furnished in valve stem seal kit) over the end of the valve stem (Fig. 13). Trim the cap if it extends more than 1/16 inch below the stem lower groove. (Plastic cap prevents sharp edges of valve stem groove from cutting valve seal).
4. Start the valve seal carefully

over the cap. Push the seal down until the jacket touches top of guide.

5. Remove plastic installation cap.
6. Grasp the seal with tool No. VSIT-1 so the end of tool contacts seal shoulder (Fig. 13) then push seal onto valve guide until it bottoms. If tool is not available, place two small screwdrivers about 90 degrees from gap in metal retaining ring and push the seal downward until it bottoms.
7. Install valve spring assembly. Compress springs only enough to install keepers. Excess compression can cause spring retainer to damage valve seal.
8. Connect the battery ground (negative) cable.

### 3 SPECIFICATION

**CYLINDER HEAD**

Engine	Combustion Chamber Volume C.C.	Valve Guide Bore Diameter (Standard Intake and Exhaust)	Valve Seat Width		Valve Seat Angle	Valve Seat Runout (Maximum)	Valve Arrangement (Front to Rear)	Gasket Surface Flatness ①
			Intake	Exhaust				
429 CJ 429 SCJ	71.2	0.3433-0.3443	0.060-0.080	0.070-0.090	Intake 30° Exhaust 45°	0.0015	I-E-I-E-I-E-I-E E-I-E-I-E-I-E-I	0.003 in any 6 inches 0.007 Overall
429 BOSS	100	0.3728-0.3735		0.085-0.100				

① Head Gasket Surface Finish R.M.S. . . . . . 90-150.

**VALVE ROCKER ARMS, ROCKER ARM SHAFT, PUSH RODS AND TAPPETS**

Engine	Rocker Arm Shaft O.D.	Rocker Arm To Rocker Shaft Clearance ①	Rocker Arm Bore Diameter	Rocker Arm Lift Ratio	Valve Push Rod (Maximum Runout)	VALVE TAPPET OR LIFTER		
						Standard Diameter	Clearance To Bore ①	Hydraulic Lifter ② Leardown Rate
429 CJ				1.73:1	20	0.8742-0.8745	0.0007-0.0027	5-50 Seconds Maximum - Measured at 1/16 inch plunger travel
429 SCJ								
429 BOSS	0.780-0.781	0.002-0.004	0.783-0.784	Int 1.53:1 Ex 1.71:1	0.015	0.8744-0.8745	0.0007-0.0027	

① Wear Limit 0.006    ② 0.005    ③ CJ Engine Only

**VALVE SPRINGS**

Engine	Valve Spring Pressure Lbs @ Specified Length		Valve Spring Free Length Approximate	Valve Spring Assembled Height Pad to Retainer	Valve Spring Out-of-Square (Maximum)
	Pressure	Wear Limit			
429 BOSS	88-96 @ 1.820 300-330 @ 1.320	80 @ 1.820 280 @ 1.320	2.03	1 13/32 - 1 27/32 Spring Seat to Retainer	
429 CJ 429 SCJ	85-93 @ 1.820 294-318 @ 1.360	77 @ 1.820 265 @ 1.360	2.079	1 13/16 - 1 27/32	5/64 (0.078)

**VALVES**

Engine	To Valve Guide Clearance		Valve Stem to Rocker Arm Clearance		Valve Head Diameter		Valve Face Angle
	Intake ①	Exhaust ①	Hydraulic Lifters	Mechanical Tappet	Intake	Exhaust	
429 CJ	0.0010-0.0024	0.0020-0.0034	0.075-0.125	0.019	2.242-2.248	1.722-1.728	Int. 29° Ex. 44°
429 SCJ				Hot			
429 BOSS				0.013 Cold	2.275-2.285	1.895-1.905	

① Wear Limit 0.0045    ② Wear Limit 0.0047

**VALVES**

Engine	Valve Stem Diameter							
	Standard		0.003 Oversize		0.015 Oversize		0.030 Oversize	
	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust
429 CJ	0.3416-	0.3416-	0.3446-	0.3446-	0.3566-	0.3566-	0.3716-	0.3716-
429 SCJ	0.3423	0.3418	0.3453	0.3453	0.3573	0.3573	0.3723	0.3723
429 BOSS	0.3711- 0.3718	0.3701- 0.3708	0.3741- 0.3748	0.3731- 0.3738	0.3761- 0.3768	0.3851- 0.3858	0.4011- 0.4018	0.4001- 0.4008

**VALVE SEAT INSERT OD**

429 BOSS	Intake 2.4935-2.4945	Insert to bore interference fit
	Exhaust 1.9935-1.9945	Standard is 0.002-0.004 (Int. & Exh)

**CAMSHAFT**

Engine	Lobe Lift <sup>①</sup>		Theoretical Valve Lift		Camshaft		Camshaft Journal to Bearing Clearance	
	Intake	Exhaust	Intake	Exhaust	End Play	Wear Limit	Clearance	Wear Limit
429 CJ			.515	.515				
429 SCJ			.500	.500				
429 BOSS	0.289	0.289	0.478	0.505	0.001 0.007	0.009	0.001 0.003	0.006

<sup>①</sup>Maximum allowable lift loss 0.005

**CAMSHAFT VALVE TIMING**

Engine	Intake Valve		Exhaust Valve	
	Opens	Closes	Opens	Closes
429 CJ	0.004 @ 32° BTC	0.006 @ 70° ABC	0.004 @ 90° BBC	0.006 @ 26° ATC
429 SCJ	0.010 @ 40.5° BTC	0.010 @ 79.5° ABC	0.010 @ 88.5° BBC	0.010 @ 31.5° ATC
429 BOSS	0.010 @ 40° BTC	0.010 @ 79° ABC	0.010 @ 88° BBC	0.010 @ 31° ATC

CA1070-A1

**CAMSHAFT**

Item	Bearing	Inches	Item	Bearing	Inches
Camshaft Journal Diameter – Standard①	(No. 1)	2.1238-2.1248	Camshaft Bearings Inside Diameter	(No. 1)	2.1258-2.1268
	(No. 2)			(No. 2)	
	(No. 3)			(No. 3)	
	(No. 4)			(No. 4)	
	(No. 5)			(No. 5)	
Camshaft Bearing Location②	(No. 1)	0.0400-0.0600			
① Camshaft journal maximum runout ..... 0.008 Camshaft journal maximum out-of-round ..... 0.0010					
② Distance that the front edge of the bearing is installed from the front face of the cylinder block.					

**CYLINDER BLOCK**

Cylinder Bore Diameter ③	Cylinder Bore Diameter 0.003 OS	Tappet Bore Diameter	Main Bearing Bore Diameter	Cylinder Block Distributor Shaft Bearing Bore Diameter	Head Gasket Surface Flatness ④
4.3600-4.3632	4.3632-4.3636	0.8752-0.8767	3.1922-3.1930	0.5155-0.5170	0.003 inch in any 6 inches or 0.007 inch overall
④ Maximum out-of-round ..... 0.001 Wear Limit ..... 0.005	④ Head surface finish RMS ..... 90-150	④ Maximum taper ..... 0.001	Cylinder bore surface finish RMS ..... 15-35	Wear Limit ..... 0.010	

**CRANKSHAFT AND FLYWHEEL**

Main Bearing Journal Diameter ⑤	Main Bearing Journal Runout-Maximum	Main Bearing Journal Thrust Face Runout	Main Bearing Journal Taper Max.	Thrust Bearing Journal Length	Main Bearing Surface Finish RMS Maximum		Connecting Rod Journal Diameter ⑥	Connecting Rod Bearing Journal Maximum Taper	Crankshaft Free End Play
					Journal	Thrust Face			
2.9994 3.0002	0.004	0.001	0.0003 Per Inch	1.124-1.126	12	20 Front 20 Rear	2.4992-2.5000	0.0004 Per Inch	0.004-0.008
⑤ Connecting rod and main bearing journal out-of-round maximum 0.0004									
⑥ Connecting rod and main bearing journal out-of-round maximum 0.0004									

**CRANKSHAFT BEARINGS**

Engine	Connecting Rod Bearings			Main Bearings		
	To Crankshaft Clearance		Wall Thickness Standard⑦	To Crankshaft Clearance		Wall Thickness Standard⑦
	Desired	Allowable		Desired	Allowable	
429 CJ	0.0010-			0.0005-	0.0005-	
				0.0015	0.0025	
429 SCJ	0.0015		0.0008-	0.0756-	0.0009	0.0955-
					0.0025	
429 Boss	0.0015-		0.0026	0.0761	0.0009	0.0958
					0.0025	
⑦ 0.002 inch undersize ..... Add 0.001 inch to standard thickness				⑧ 0.002 inch undersize .....		

**CAMSHAFT DRIVE MECHANISM**

Crankshaft Gear or Sprocket	Timing Chain
Assembled Face Runout TIR Max	Deflection (Maximum)
0.006	0.500

**CONNECTING ROD**

Piston Pin Bore Or Bushing I D ①	Connecting Rod Bearing Bore Diameter ②	Connecting Rod Length Center To Center	Connecting Rod Alignment Maximum Total Difference ③		Connecting Rod Assembly (Assembled To Crankshaft)	
			Twist	Bend	Side Clearance	Wear Limit
1.0386- 1.0393	2.6522- 2.6530	6.6035 6.6065	0.012	0.004	0.010- 0.020	0.023
①Piston, pin bushing or bore Maximum out-of-round . . . . .		0.003				
Maximum taper . . . . .		0.0005				
②Connecting rod bearing bore maximum out-of-round and taper . . . . .		0.0004				
③Pin bushing and crankshaft bearing bore must be parallel and in the same vertical plane within the specified total difference at ends of 8-inch long bar measured 4 inches on each side of rod.						

**PISTON**

Diameter ①			Piston To Cylinder Bore Clearance	Piston Pin Bore Diameter	Ring Groove Width
Coded Red	Coded Blue	0.003 Oversize			
4.3569- 4.3575	4.3581- 4.3587	4.3593- 4.3599	0.0030- 0.0038	1.0402- 1.0405	Upper Compression Ring 0.080-0.081 Lower Compression Ring . . . 0.080-0.081 Oil Ring . . . 0.1880-0.1890
①Measured at the piston pin bore centerline at 90° to the pin above.					

**PISTON PIN**

	Diameter				To Piston Clearance	To Connecting Rod Bushing Clearance
	Length	Standard	0.001 Oversize	0.002 Oversize		
429 CJ					0.0001-① 0.0003	Interference Fit
429 SCJ	3.290- 3.310	1.0400- 1.0403	0.9760- 0.9763	0.9770- 0.9773		
429 BOSS					0.0003- 0.0005	0.0008

**PISTON RINGS**

Ring Width		Side Clearance				Ring Gap Width		
Compression Ring		Compression Ring ①		Oil Ring	Compression Ring		Oil Ring ②	
Top	Bottom	Top	Bottom		Top	Bottom		
0.077- 0.078	0.077- 0.078	0.002- 0.004	0.002- 0.004	Snug	0.010- 0.020	0.010- 0.020	0.010- 0.035	
① Wear Limit . . . . . 0.006								
② Steel Rail								

**OIL PUMP**

Rotor-Type Oil Pump Relief Valve Spring Tension Lbs @ Specified Length	Drive Shaft To Housing Bearing Clearance	Relief Valve Clearance	Rotor Assembly End Clearance	Outer Race To Housing (Radial Clearance)
20.6-22.6 @ 2.49	0.0015-0.0029	0.0015-0.0029	0.0011-0.0041	0.006-0.013

**APPROXIMATE OIL PAN CAPACITIES**

Engine	U.S. Measure	Imperial Measure
429 CJ	5 quarts ①	4 1/8 quarts
429 SCJ	6 quarts ①	5 quarts
429 BOSS	6 quarts-Fairlane ② and Montego 8 quarts-Mustang ② and Cougar	5 quarts-Fairlane and Montego 6 2/5 quarts-Mustang and Cougar

① Includes 1 quart with filter replacement and 1 quart for oil cooler  
② Includes 1 quart with filter replacement

**TORQUE LIMITS**

Engine	Cylinder Head Bolts			Oil Pan To Cylinder Block	Manifolds To Cylinder Head		Water Outlet Housing	Distributor Vacuum Control Valve	Flywheel To Crankshaft
	Step 1	Step 2	Step 3		Intake	Exhaust			
429 CJ			130-140	9-11 (5/16-18)	25-30	28-33	12-15	15-18	75-85
429 SCJ	75	105		7-9 (1/4-20)					
429 Boss	55-60	75-80	90-95						

Engine	Main Bearing Cap Bolts	Oil Pan Drain Plug	Oil Pump To Cylinder Block	Oil Pump Cover Plate	Oil Filter Adapter To Cylinder Block	Oil Filter To Adapter	Cylinder Front Cover
429 CJ	(7/16-14)	15-25	20-25	6-9	60-100 insert 50 Bolt	With grease on the gasket surface, hand-tighten until gasket contacts adapter face, then tighten 1/2 turn more.	12-15
429 SCJ							
429 Boss		70-80					

Engine	Water Pump To Cylinder Block Or Front Cover	Camshaft Sprocket To Camshaft	Camshaft Thrust Plate In Block	Damper Or Pulley To Crankshaft	Connecting Rod Nuts	Valve Rocker Arm Cover
429 SCJ	12-15	40-45	9-12	70-90	40-45	5-6
429 SCJ				*	85-90	12-15
429 Boss						

Engine	Oil Inlet Tube To Oil Pump	Fuel Pump To Cylinder Block Or Cylinder Front Cover	Pulley To Damper Bolts	Air Manifold Thermactor	Check Valve To Air Manifold Thermactor	Adjusting Arm To Air Pump-Thermactor	Air Pump Mounting Bolts-Thermactor	Air Pump Drive Pulley To Pump Hub-Thermactor
429 CJ	12-15	20-24	35-45					
429 SCJ				To Cylinder Head 16-19	16-19	16-20	16-26	7-9
429 Boss				To Exhaust Manifold 6-9	16-19	16-20	16-26	7-9

Engine	Valve Rocker Shaft Support To Cylinder Head	Valve Rocker Arm Stud To Cylinder Head	Valve Rocker Arm Adjusting Nut
429 CJ		17-23	18-20 ft-lb After Nut Contacts Shoulder (Positive Stop Type Stud Nut)
429 SCJ			
429 Boss	12-15		20-30 ft-lb

**TORQUE LIMITS-ENGINE SUPPORTS-CJ AND SCJ ONLY**

	Fairlane-Montego	Cougar-Mustang		Fairlane-Montego	Cougar-Mustang
ENGINE FRONT SUPPORTS	429	429	ENGINE REAR SUPPORTS	429	429
Front Insulator to Engine			Rear Support Assembly to Transmission		
Insulator Upper Bracket	35-60	35-60	Insulator Assembly to Transmission: Manual	30-45	30-45
Front Support Insulator Bracket to Insulator	30-50	30-50	Insulator to Crossmember	30-50	30-50
Front Insulator Through Bolt	20-30	20-30	Rear Support Assembly to Crossmember		
Support Bracket to Crossmember	20-30	20-30	Crossmember to Frame	50-70	50-70
			Frame Bracket to Frame Rail Nuts		

CA1070-A5